ENVIRONMENTAL QUARTERLY

July • 1961

The Recognized Journal of Environmental Simulation

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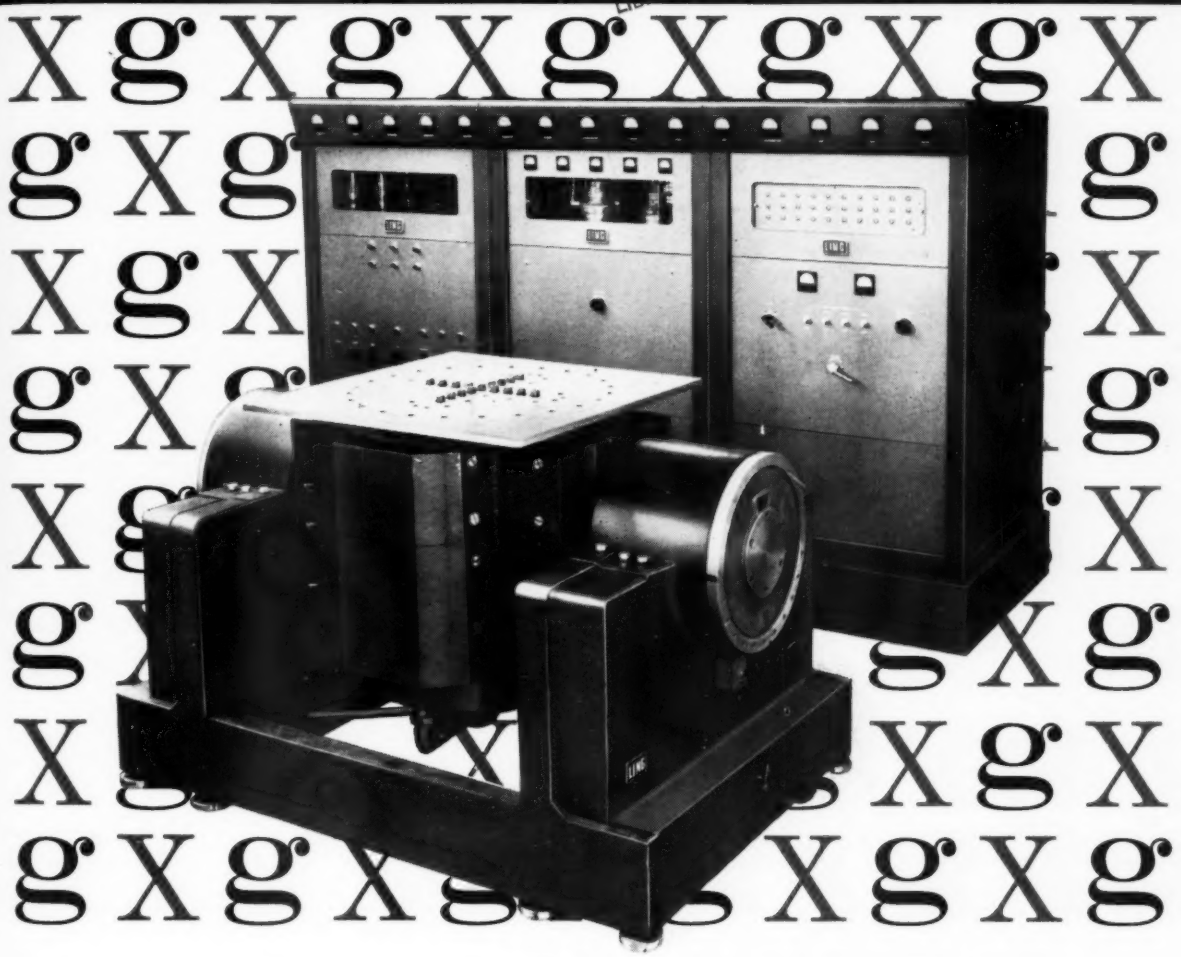
HIGHLIGHTS OF THIS ISSUE:

- *3 Pages of Show Photos*
- *High, Wide and Spatial*
- *A Seminar in Vibration*

INDEPENDENTLY PUBLISHED

Volume 7 • Number 3



ONLY LING'S NEW X-ARMATURE SHAKER TAKES 75 pound packages to 100 "g"... 208 pounds to 60 "g"

Ling brings you another important development in vibration testing—the revolutionary L-200 Shaker with the capability needed to test heavier packages at higher "g" levels than ever before. The L-200, with a force rating of 20,000 pounds, is designed on a new Ling concept. The unique "X" design armature develops uniform force on two rows of mounting studs which are set in an "X" pattern on the big table. An exceptionally low stray field—less than 3 gauss at table level—protects sensitive guidance packages. The armature weight is only 125 pounds. This, plus efficient coupling, lets you take a 75-pound package up to 100 "g" or a 208-pound package to 60 "g"—a performance no other shaker can match. The L-200's interior is completely sealed off to screen out all chips, dust or contaminants, and is designed to allow environmental test adaptability. For more details on the advantages of the L-200, write to Department EQ-761A at the address below.

LING-TEMCO ELECTRONICS, INC.

LING ELECTRONICS DIVISION

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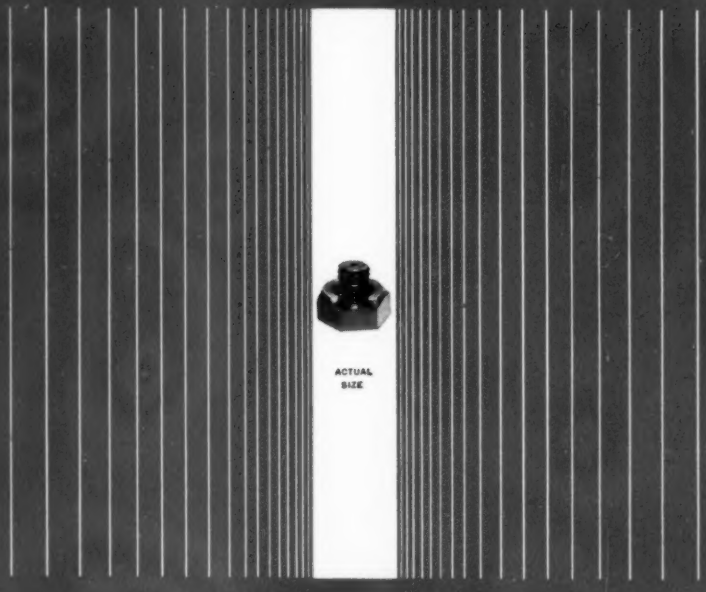
AT LAST . . . A MICROMINIATURE ACCELEROMETER THAT WORKS!



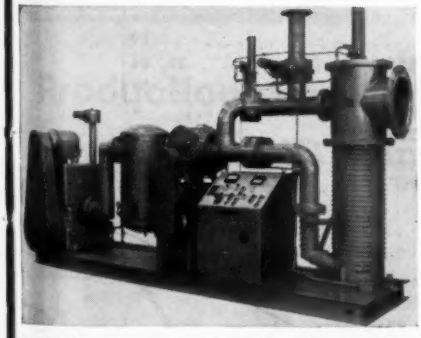
Introducing a microminiature accelerometer with standard Endevco reliability and performance . . . the Endevco Model 2226 (photo above) for cement mounting. Provides 5.0 pk-mv/pk-g output with six foot cable . . . weighs only 2.75 grams. Also available as Model 2227 with integral 6-32 stud and as the Model 2229 with insulated stud . . . the Model 2228 Tri-Axial Accelerometer is only 0.600" square x 0.420" high. Standard detachable cables are supplied with all Models. Write Department "T."

ENDEVCO CORPORATION

181 East California Boulevard • Pasadena, California • Phone: SYcamore 5-0271

This 10" High Vacuum Pumping System was recently shipped to a manufacturer of environmental chambers for evacuation to simulated altitudes to 500,000 feet.

SAVE DESIGN MANPOWER AND CUT COSTS WITH STOKES HIGH VACUUM PUMPING SYSTEMS



Designed to evacuate an aerodynamic wind tunnel facility, this specially designed unit features 3 stages; mechanical pump, Roots type blower and 16" diffusion pump. System is base plate mounted and includes a graphic control panel. The unit is one example of Stokes ability to meet out-of-the-ordinary system requirements.

Now, your valuable engineering time can be saved for direction to other phases of your project. Stokes solves the vacuum portion of your problem with completely packaged pumping systems. Whether your test needs are 150,000 feet or 1,500,000 feet of simulated altitude, and test volume requirements are 10 cu. ft. or 10,000 cu. ft., Stokes has the system to do an effective and efficient pumping job.

Stokes oil booster type and diffusion type systems are designed to meet your needs for *compactness*, *reliability* and *efficiency*. The 10" diffusion system in the illustration above, for example, requires only 20 square feet of floor space. Engineered around Stokes proven vacuum components, all systems include base plate, interconnecting piping, point-to-point wiring as well as the control console.

Stokes provides you with all the extras, too: push buttons, pilot light, contactors, starters and gaging. In addition, your installation costs and start-up time are reduced since field assembly is limited to one vacuum connection and three utility connections.

Why not let our Advisory Service study your particular requirements and make system recommendations. Today, while it's fresh in your mind, write to Stokes for complete information.

STOKES

Vacuum Equipment Division
F. J. STOKES CORPORATION, 5500 Tabor Road, Philadelphia 20, Pa.

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Environmental Quarterly

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Environmental Quarterly welcomes competent expressions of opinion, but statements in its pages do not necessarily reflect its views. Right is reserved to extract portions of letters and other material submitted for publication. Correspondents must identify themselves fully, but names will not be published if such a request is made.

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ENVIRONMENTAL QUARTERLY

The Premier Space Age Publication of Environmental Simulation, Testing, Engineering and Equipment Manufacturing

July • 1961 Volume 7 • Number 3

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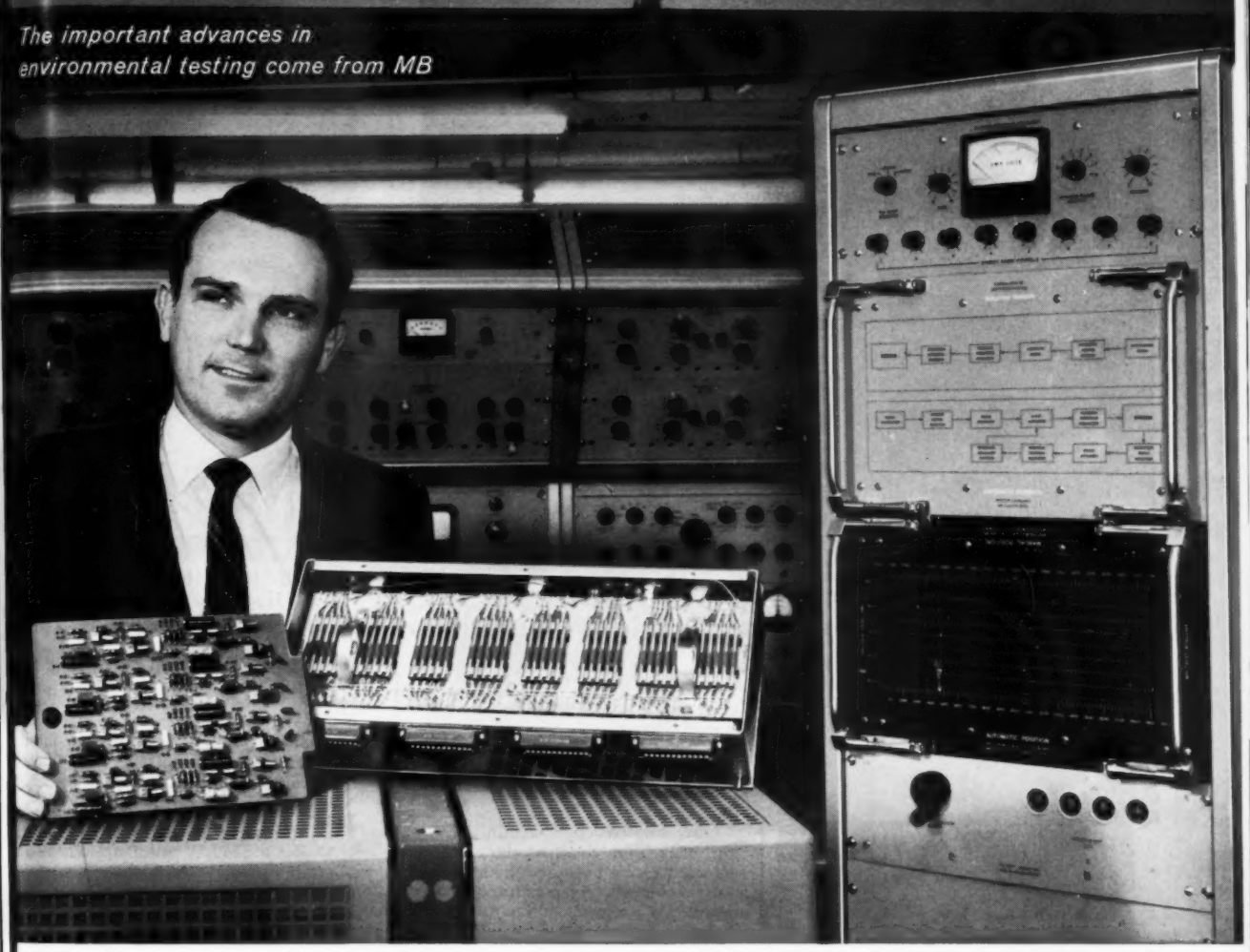
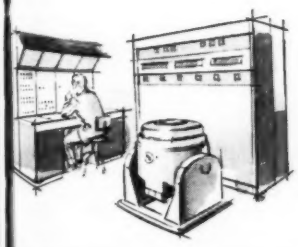
The important advances in environmental testing come from MB



Production random vibration now practical with MB completely automatic spectrum equalizer



eart of the MB automatic equaliza-on system is the multi-channel tran-istorized amplifier which provides mplitude control. The plug-in printed rcuit assembly shown above con-ins four of these channels. Fre-ency control is provided by the 0-channel filter assembly in the ompact metal box.

MB's completely automatic spectrum equalizer simplifies test procedure and makes production random vibration testing practical. It effects tremendous savings in test time and money for missile and aircraft manufacturers. The reason: set-up time has been completely eliminated. Using solid state magnetostrictive filters with correct phase properties plus servo systems on each of eighty channels in the 15 to 2000 cps spectrum, vibration shaker systems can be completely equalized within 5 seconds.

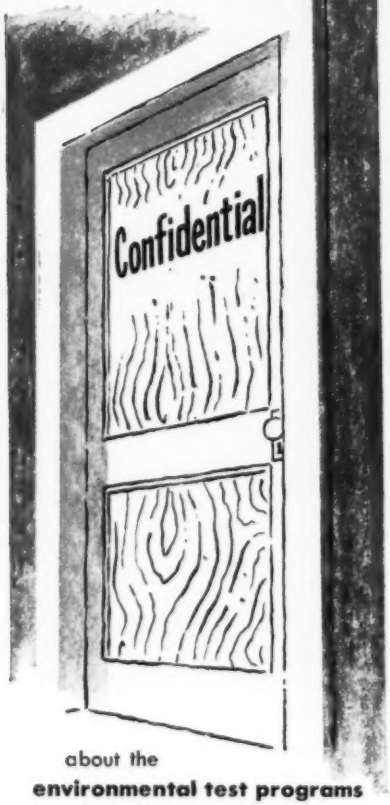
Savings in time and labor over previous equalization methods can easily mean thousands of dollars per missile tested. Still another advantage is the greatly increased accuracy of accumulated test data. The spectrum is continuously monitored in narrow bandpass channels and compensation automatically made *during* test run.

Automatic spectrum equalization is another of MB's important and continuing contributions in the field of environmental testing.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC., 1057 State Street, New Haven 11, Conn.

WE'D LIKE TO BRAG...



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Post Scripts

Window on the Environment

Recent progress in environmental testing is reflected in the unobtrusive windows that give view to conditions found nowhere else on earth.

"Just a short five years ago," reports Eugene L. Goodman, secretary and chief engineer of National Du-O-Pane Corp., Brooklyn, "most test chambers required a maximum temperature performance of 350°F when windows were incorporated into the construction. Today we consider 600° windows a normal item and have produced custom-made windows with an operating range of —50° to +1000°F."

Goodman joined Du-O-Pane, which began in the flat glass business in 1916, after five years in the World War II Army Engineers. As a result of a research program he instituted, the company began to market insulating glass in 1950, and today it is engaged exclusively in the manufacture of insulating glass units for all purposes.

Trend Is Toward Salvage

As regards test chambers, Du-O-Pane has noted a new trend, which it attributes to constantly increasing costs. This is the effort to salvage viewing windows when there is breakage or leakage.

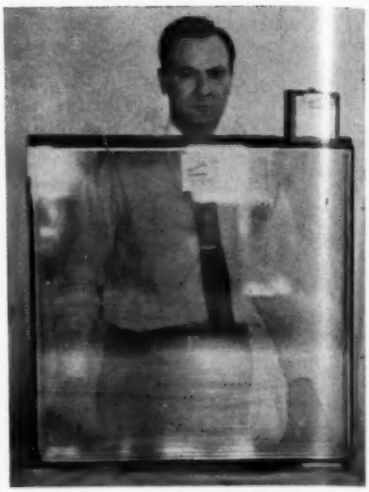
"Our experience," Goodman says, "has been that the manufacturers do not want to be bothered with replacement problems. As a result, we have instituted a program of reconstruction, whereby unserviceable windows are shipped directly to us. We rip them apart, discard any valueless glass, supply new pieces and reconstruct the window to the original specification at a great saving compared to the cost of an all-new unit. Many times, during reconstruction, new ideas can be incorporated into these old windows, enabling them to withstand even higher temperatures and pressures than originally specified."

In the same way, test chamber manufacturers can upgrade inventories of windows which may now be outmoded. Du-O-Pane reports that most formulae for glass safety loads have a safety factor of 10 built in.

Large Safety Factor

"This," Goodman explains, "is because glass accumulates stress to a certain degree. Since maximum stresses are usually of short duration, and the life term of the glass at high stress is lengthy, maximum safe loads as recommended can usually be exceeded many times without failure."

For the manufacturer of test chamber glass, the state of the art is always changing. Not only must he be concerned with new test specs placing greater demands on his product, but he must be alert to improvements in his own area, such as specialized glasses and adhesives.



THROUGH THE GLASS: Du-O-Pane's Goodman demonstrates two sizes of environmental windows.

And just like the environmental engineer he serves, the glass manufacturer, Mr. Goodman points out, must learn that materials often react differently under field usage than in the lab.

This Matter of Clarity

A picture, it is said, is worth a thousand words, which makes this issue of Environmental Quarterly somewhat encyclopedic. In addition to record numbers of pictures of products and people, there are three full pages of scenes of the colorful equipment exposition held last Spring in conjunction with the IES show in Washington.

Pictures or no, words are still our primary means of communication. Most persons, including professional writers, have trouble keeping the communication channel clear. Yet some authors bitterly resent having so much as a comma of theirs changed. The fact is that any editor worth his salt can do something to improve a piece of prose, and an author's purpose, in this context, should be to get his ideas across, not to luxuriate in his language.

Environmental Quarterly has a not-so-secret conviction that even long-winded technical articles can be made readable—meaning more enjoyable and more enlightening—if they are carefully edited. Therefore, as much time or more goes into that aspect of each issue as into any other. We hope the results of this effort are apparent.

'Make the People Understand'

Among the professionals, the subject of clear writing is always good for a speech. E. Gary Clark, manager of the Burroughs Corporation's Research Center, Paoli, Penna., addressed him-

self to that very subject recently at a meeting of the Delaware Valley Chapter of the Society of Technical Writers and Publishers.

"Use terms of significance, rather than relying on the catch phrase," he urged. "Let us strip the mystery away from science; let us interpret scientific activities in words that other workers, and the public at large, can understand. . . . Only when the scientific field has lost its self-created mystery will it have the understanding and complete support of the people."

For those interested in pursuing the matter, a symposium on engineering writing and speech will be held at Michigan State University's Kellogg Center for Continuing Education, East Lansing, next Oct. 16-17. The theme: "Communicating Ideas—The Modern Engineer's Function."

What'll Ya Have?

A faithful follower has come up with an excellent suggestion we are seizing upon immediately as a matter of service, to wit: a classified ad section in which readers can announce their interest in obtaining equipment—new or used.

For a long time, it has been Quarterly's policy to publish "situation wanted" ads free of charge under certain conditions. This is now extended to include "equipment wanted" ads. So if anyone hankers for a second hand widget or a slightly used vacuum, here's one way to ask around for it.

Read the rules that precede ENVIRONMENTAL WANT ADS on the New Products page. Those that refer to "situation wanted" ads apply here, too. We have always accepted ads offering used equipment for sale and will, of course, continue to do so, subject to the same rules as heretofore. The wanted equipment must, of course, be something one would reasonably expect to find in the environmental test field.

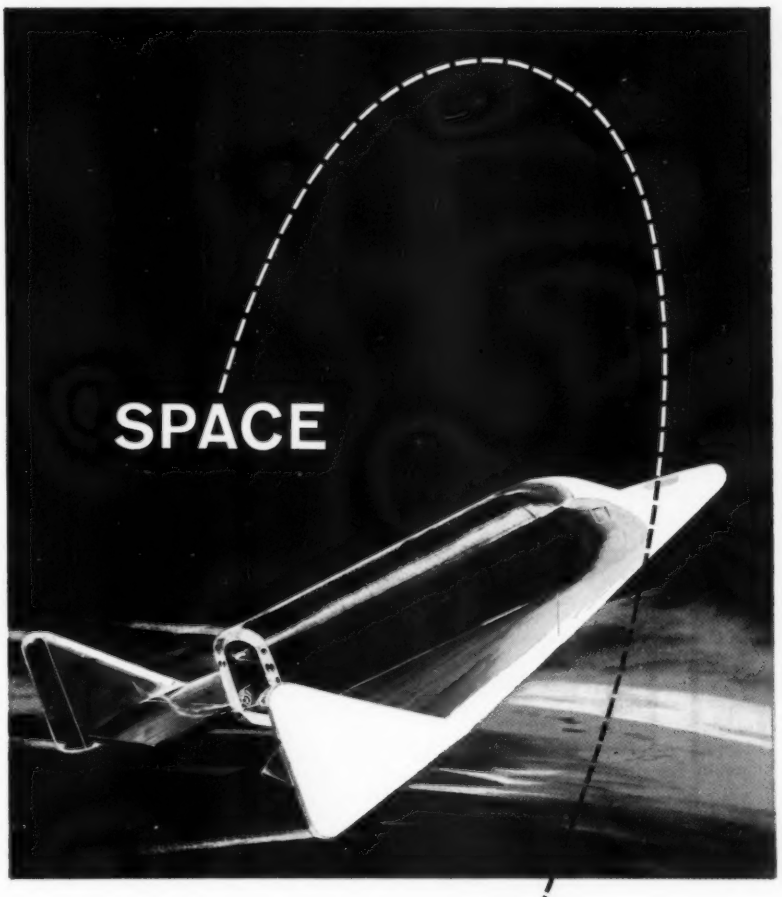
This equipment "swap shop" is an extension of the "Idea Swap Shop" we tried to get going two years ago. The first reaction to that idea was most encouraging, but then it fizzled. Presumably, everyone in this industry knows what he needs to know or requires no help in finding it.

However, the idea still stands—or lies dormant, if you will. If you are stumped by some problem or other, perhaps one of your fellow readers can steer you to the answer. Drop us a line.

Environments Abstracts

One reason so few questions are floating about might well be the Prevention of Deterioration Center's new abstracts series entitled "Environmental Effects on Materials & Equipment."

Announcement of this series was made in our January, 1961, issue. We have since seen the abstracts and are greatly impressed with their presentation, scope and thoroughness. Carl J.



TO BASE

With leading edges glowing from friction heat, the Air Force's Dyna-Soar manned space glider will make critical passage into earth's atmosphere.

Boosted into space by a modified Titan intercontinental ballistic missile, the Dyna-Soar will be left in piloted, near-orbital flight. At the pilot's choosing, he can glide into atmosphere to a conventional landing at an Air Force base.

To make it a safe flight, Boeing, system contractor for Dyna-Soar, is pre-testing all Dyna-Soar materials in accurately simulated space-to-base flight conditions. A Consolidated Vacuum test chamber reproduces the full environmental range—from atmosphere to as far out as 400 miles. This CVC chamber brings outer space down to earth . . . long before Dyna-Soar's first flight, Boeing engineers *know* what the spacecraft can withstand.

The same CVC capabilities are ready to provide complete turn-key facilities for *your* reliability testing program. Just check with the nearest CVC Sales Office, or the Custom Products Division, CVC, Rochester 3, N. Y.

Consolidated Vacuum Corporation

ROCHESTER 3, NEW YORK

A SUBSIDIARY OF CONSOLIDATED ELECTRODYNAMICS/BELL & HOWELL

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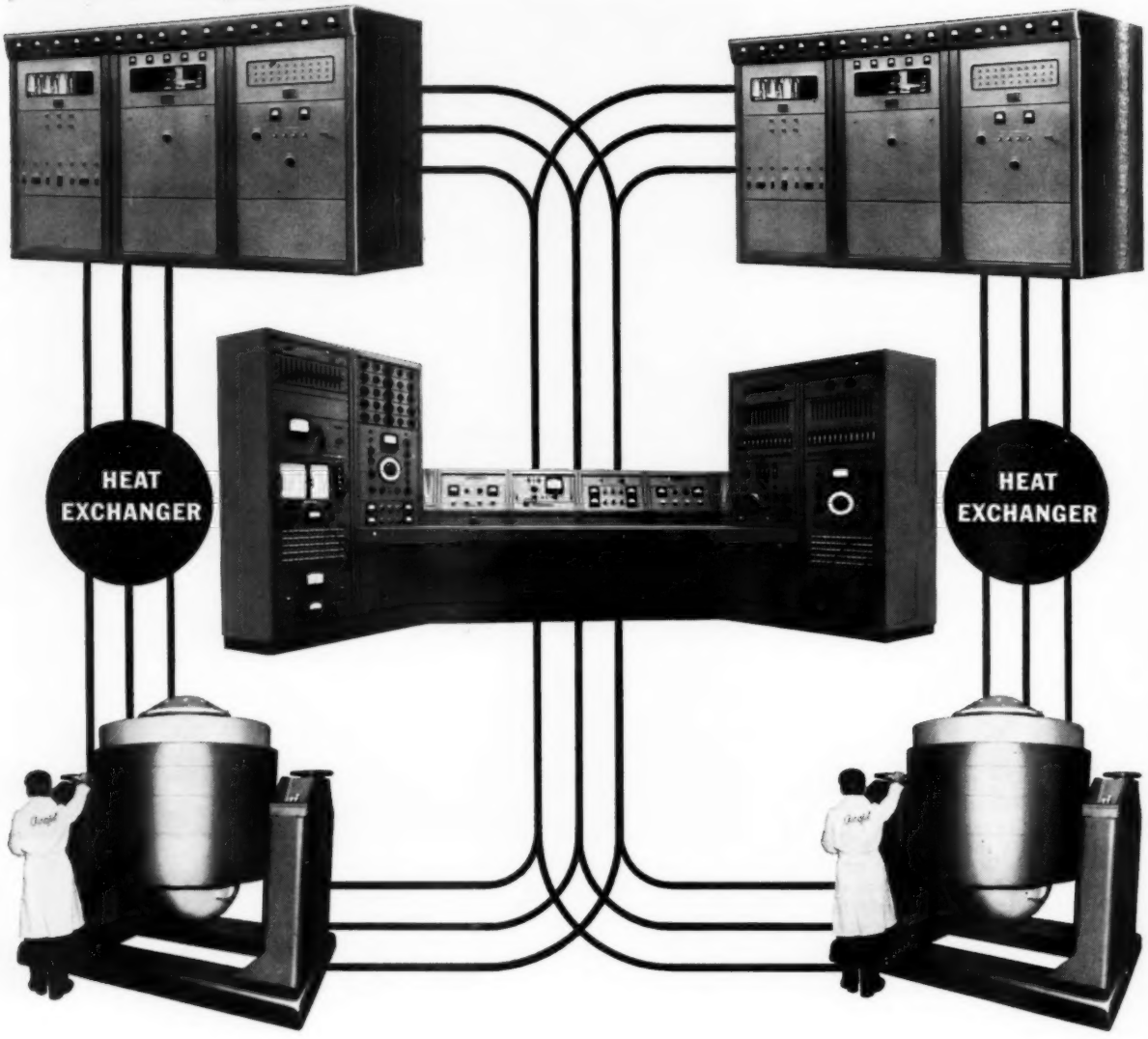

A BETTER SHAKE FOR POLARIS... Aerojet-General installs Ling vibration system with world's highest force rating - 60,000 pounds

When faced with unsolved vibration testing problems on its vital part of the Polaris program, Aerojet-General Corporation, a subsidiary of The General Tire and Rubber Company, turned to Ling Electronics. To give its solid propellant rocket engines the severest shake-up, Aerojet-General improved its test facilities with two Ling vibration systems—controlled simultaneously or independently by one console. The system, now operating, includes two Model 249 shakers delivering 30,000 pounds force each and two Model PP 120/150, 120 KVA water-cooled amplifiers—for a total force delivery of 60,000 pounds. The special random/sine wave console not only provides simultaneous or independent control of both exciter systems, but features Ling's famous ESD-ASD 20 spectral density equalizer/analyzer, the industry standard. Like Aerojet-General, you too may find the superior quality and rugged reliability of Ling systems answer your testing problems. For more information, write Department EQ-761 at the address below.

LING-TEMCO ELECTRONICS, INC.

LING ELECTRONICS DIVISION

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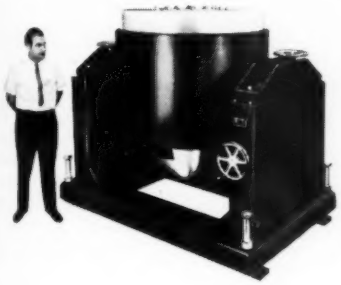
LING ELECTRONICS

The powerful Ling vibration system shown at the left is just one more example of the way Ling's continuing program of research serves industry and defense programs.

As package weights rise, so does the need for vibration testing systems of higher performance and reliability. And Ling engineers have consistently anticipated these demands with designs that keep pressing toward higher ratings.

The powerful Model 249 shaker shown below delivers 30,000 pounds of force when combined with its mating amplifier. Only the high force rating of the 249 shaker made it possible to meet the big systems needs of Aerojet-General as described at the left.

Ling amplifiers offer equally impressive ratings. Ling pioneered in the manufacture of electronic amplifiers for driving electro-dynamic shakers and has produced liquid-cooled amplifiers that deliver from 10,000 to 5,000,000 watts.



Listed below are performance ratings of high power Ling vibration systems employing the Model 249 shaker:

LIQUID-COOLED SHAKER	LIQUID-COOLED AMPLIFIER	FORCE LBS. SINE	FORCE LBS. RANDOM
249	PP 175/240	30,000	32,000
249	PP 120/150	30,000	28,000
249	PP 75/90	23,000	21,000

Whatever your needs in high power electronics—vibration testing, acoustics or sonar, you'll find Ling systems offer high performance, high reliability, and quality that sets the standard.

LING-TEMCO ELECTRONICS, INC.
LING ELECTRONICS DIVISION
HIGH POWER ELECTRONICS FOR VIBRATION TESTING • ACOUSTICS • SONAR

Wessell, director of the PDC, and his staff are to be congratulated on an excellent job.

"Environmental Effects" is free to the armed forces and qualified agencies. To others the price is $25 a year (published monthly).

PDC, established in 1945 as an outgrowth of the wartime OSRD-NDRC Committee on Tropical Deterioration, is supported by Armed Forces funds through an ONR contract with the National Academy of Sciences. Another of its excellent publications is the "Newsletter," now edited by Hans Janecka, which consistently presents illuminating observations on the state of the Environment.

In a recent issue, Dr. Wernher von Braun, director of NASA's Marshall Space Flight Center, discussed "The Deteriorating Effects of the Space Environment." Here, with permission, are some of his comments:

'New Set of Problems'

"As we move into space, the designer is confronted with a new set of problems based upon the space environment. So far, one major source of difficulty is the lack of knowledge as to how serious the environmental conditions of space really are. Furthermore, the lack of facilities to simulate the whole space environment hampers development of suitable materials and design data on these materials in the environment.

"The vacuum of space affects materials in two ways: evaporation of the material or a volatile component of the material, and/or removal of the layer of adsorbed gas on its surface. Evaporation of one or more components of a material will result in changes of the bulk mechanical and physical properties. The removal of surface gas is known to affect friction especially, and perhaps other properties of materials.

"The rate of evaporation of most metals will not be a significant problem in space if the temperature is kept below about 300°F. Likewise, organic polymers of high molecular weight (10,000 or more) will have such low vapor pressures that their evaporation rates in vacuum will be very low. However, if one superimposes on the vacuum another component of the space environment, radiation, then the degradation of polymers by evaporation may become important. Irradiation of high polymers can produce chain scission, resulting in fragments of lower molecular weight and, consequently, higher vapor pressures. Thus, these two aspects of the space environment combined can degrade materials substantially.

Other Aspects of Space

"The problem of lubrication in the hard vacuum of space is one of the most pressing ones, particularly for intermittently moving parts. Mating metal parts tend to weld together in the space environment.

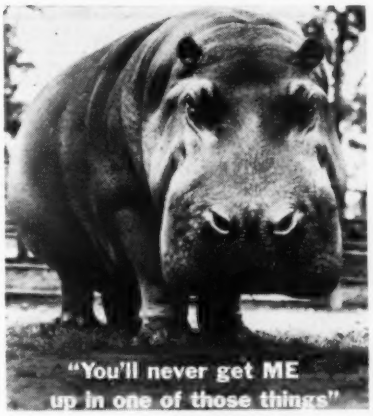
"The temperature extremes of space also will constitute materials problems, particularly the repetitive heating and cooling, for example, of an earth satellite.

"At least one aspect of the space environment may be less severe than our normal environment and that is the problem of fatigue. Apparently, the vacuum environment increases the fatigue life of oxide forming metals.

"Meteorites, micrometeorites and cosmic dust are environmental hazards to space flight. This problem requires the development of effective meteorite bumpers for space vehicles, adding a weight penalty to the vehicle.

"After living in the environment of earth for so many years, man finds the space environment exceedingly hostile. As surely, however, as man has learned to fly in the earth's atmosphere, he will learn to fly in the new environment of space."

Words Without Music



Courtesy Endevco Corporation

ASHRAE Donating Facility To Kansas Research Center

The Kansas State Environmental Research Center, Manhattan, Kan., will be presented this summer with a $150,000, controlled-environment facility now at the Cleveland laboratory of the American Society of Heating, Refrigerating & Air Conditioning Engineers. ASHRAE is closing its Cleveland installation.

The research center was recently established by the Kansas State University of Agriculture and Applied Science.

In the End, It's Zuni

A new space-age dictionary, launched with the high purpose of contributing to "a common understanding of terms that play an integral part in mankind's forward movement," travels from "ablating materials" to "Zuni—a Navy air-to-surface rocket for use against tanks, pilboxes, trains, ammunition and fuel dumps, small ships, etc."

The 75-page, 1300-entry dictionary, entitled "Interim Aerospace Terminology Guide" was compiled by the Air Force.

Billet, at IES Helm, Sees Key Role in Space Flight

(Forty-four companies, including Environmental Quarterly, participated in the trade show that accompanied the IES technical meeting April 4 to 7 in the Sheraton-Park Hotel, Washington. For a comprehensive tour of the exciting show, turn to Pages 24 to 26.)

Environmental science "will play an extremely important part in the advancement of space flight" as a result of activities of the Institute of Environmental Sciences and its individual members within the environmental industry, Arthur B. Billet, newly elected president of the IES, declared.

Billet, senior staff engineer of Vickers Inc.'s Aero Hydraulics division in Detroit, and a new slate of officers were handed the responsibility of running the IES at the society's annual meeting April 5 in Washington. Billet, who was executive vice president last year, succeeded William L. Vandal to become third president of the IES.

"With the United States on the threshold of space exploration," the scientific efforts and the technical organizations of the country have the greatest challenge of their existence," he said.

Society's Growth Cited

Billet cited the IES' growth in seven years, from one chapter with a few members to 10 chapters with 1,000 members and three more chapters forming, as proof that environmental activities comprised an area in need of technical advancement and information dissemination.

Originally two societies, the IES was formed in a merger in 1959.

Next Year's Meeting

The 1962 annual meeting and equipment exposition of the IES will be held in Chicago's Sheraton Towers Hotel, April 10 to 13.

A call for papers has been issued by Frank P. Merry, technical program chairman. Abstracts of 350 to 700 words must reach him at 1817 S. Chaparro, Las Cruces, N. M., by Oct. 1. Final papers must be submitted by Jan. 15.

Original papers are sought on environmental effects, simulation, research, techniques and measurements in induced, natural and outer space environments, including the biological, medical and nuclear areas.

PREXY AND GUEST: Arthur B. Billet (right) newly installed president of the IES, is shown with luncheon speaker Kurt Stehling, of NASA.

"The IES has a number of immediate programs that are being worked on by various committees," Billet added. "In the case of the national meeting, an even larger and better one is planned for Chicago next year. There is to be extreme emphasis placed on the quality and high engineering value of these sessions."

Other programs now engaging the attention of the IES include as an extension of very successful seminars being sponsored by local chapters in cooperation with local universities, and work on standardization of environmental terminology.

Fox Moves Into Line

Serving with Billet until next April are: Donald J. Fox, executive vice president; Mark Christensen, fiscal vice president; Gerhard Doering, vice president—local chapters; Herbert J. Saunders, vice president—membership, and John D. Campbell, vice president—publications. Henry F. Sander was reappointed executive secretary. He maintains national offices at 34 S. Main St., Mt. Prospect, Ill.

In the past, the society has promoted its executive vice president to the presidency. Thus Fox, recently appointed midwestern regional sales manager for Fenwal, Inc., is in line to succeed Billet.

A native Chicagoan, Fox is a graduate of the Illinois Institute of Technology. He is a past president of the Chicago and Dayton IES chapters. During World War II he served in Italy and Africa in the Air Force.

Chaired National Meeting

Billet, another Air Force veteran, was general chairman of this year's meeting and accompanying equipment exposition. In two prior years he served as national program chairman. He was a vice president of the IES for five years, including two as fiscal

Fox

Campbell

Sander

Saunders

chief and one each in charge of local chapters and membership. He has also headed the Detroit chapter.

Other New Officers

Doering, who is with Columbia Research Laboratories, Woodlyn, Penna., is the only other reelected officer, continuing as chapters vice president. Campbell, who manages the Environmental Test department of Philco's Western Development Laboratories, Palo Alto, Calif., is originally from Florence, S. C. A graduate of San Jose State College, he is also a member of the American Society for Testing Materials and has been active in the IES' Northern California chapter.

Christensen, the new fiscal vice president, is with Wyle Laboratories, El Segundo, Calif. Saunders, who will head the membership program, is with Vapor Heating Corp.'s Vap-Air division in Chicago, where he is chief qualification test engineer. He was secretary of the Greater Chicago chapter of IES and handled publicity for the 1959 meeting of the society.

Lopicollo Award Presented

The 1960 Thomas Lopicollo Award for an outstanding contribution to environmental science has been awarded jointly to Capt. Edward B. Magid, of Chicago, and Dr. Rolf R. Coermann, Yellow Springs, Ohio, for their paper, "The Reaction of the Human Body to Extreme Vibration," at the 1960 IES meeting. Cash awards of $100 each were made by the Environmental Equipment Institute at the recommendation of the IES.

NOISE LIKE YOU NEVER HEARD AT HOME!

In fact, we know of no other available acoustic noise test facility with sound intensities to 150 db through a frequency range of 20 to 20,000 cps with a working volume of 15 cubic feet. This is only one example of the large number and variety of test chambers and facilities in Associated Testing Laboratories' 30,000 square foot plant in Wayne, N. J., 10,000 square foot facility in Winter Park, Fla., and 15,000 square foot laboratory in Burlington, Mass.

A few more examples of the tremendous scope of Associated's environmental test equipment:

- **7,500 lb-force sine and random vibration capability with latest automatic equalization equipment.**
- **12,500 lb-force sinusoidal vibration capability.**
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- **Variable-pulse saw-tooth or square wave shock machine.**
- **Chamber capabilities through a 12′ x 12′ x 11′ High-Low Temperature-Humidity Chamber.**

In addition, Associated's facilities provide complete instrumentation for testing and recording almost all equipment—including digital reading and print-out equipment especially designed for component testing.

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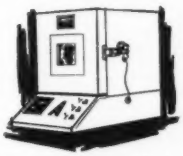
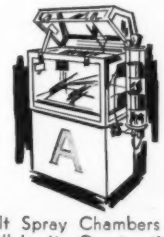


Econ-O-Line Low-High Temperature Test Chamber Liquefied CO_2

Low-High Temperature Test Chambers Liquefied CO_2 or Cascade Refrigeration



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Now you can get dynamic response characteristics well beyond the capabilities of conventional test machines by using DYNATEST Model DTM-3. The new machine meets demands created by rapid technological developments in nuclear, aeronautical, space vehicle and propulsion fields.

The Dynatest machine features a high-speed DYNAJACK* electrohydraulic ram arranged to program force and strain applied to the specimen. Continuous cyclical force or strain versus time may be employed with manual or full automatic programming. Temperature programming is accomplished by close coupled resistance heating or combinations of resistive inductive or radiant heating. Temperature is detected with a low mass thermocouple welded to the specimen.

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Complete specifications and details are in Data Sheet S-101. Write for your copy today.

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Clinic Is Planned At Shock Symposium

The possibility of holding a "Shock and Vibration Clinic" is being considered as part of the 30th Symposium on Shock, Vibration and Associated Environments to be held at the Statler-Hilton Hotel, Detroit, Oct. 10-12. Two forms of clinic are being studied: a general discussion of controversial subjects, such as random vs. sine equivalence, or presentation of specific problems to a panel or to the audience in general.

The symposium will feature papers, given in parallel sessions, on extreme operational environments and on transportation and packaging environments. Sessions and tutorial papers now planned are as follows:

Subjects Listed

Missile vibration and noise; mechanical impedance, with Dr. R. O. Belsheim, chairman, and tutorial papers on analytical determination, experimental determination and applications; radiation phenomena, with tutorial paper, "The Significance of Transient Radiation Effects on Electronics," by Peter H. Haas, Diamond Ordnance Fuze Laboratory, and other papers by T. D. Hanscome, Hughes Aircraft; Robert Boham, IBM, and Donald Hicks, Boeing; shipboard shock problems, with tutorial paper, "A Survey of the Shock Problem in the Navy," by Harry Rich, David Taylor, Model Basin; space environments—measurement and simulation, with tutorial paper by John New of NASA, and unique test facilities for extreme environments.

Also, measurement and definition of transportation environments; aerial delivery of supplies and equipment, with opening paper, "Cushioning for Aerial Delivery," by E. A. Ripperger and J. N. Thompson, University of Texas; isolation of packaged items, with opening paper by Robert K. Stern, of Forest Products Laboratory; simulation of transportation environments, and container design for missiles.

Valid secret clearance is required for attendance.

Gifts from Industry Help Wyo. Environmental Lab

A number of gifts from the environmental industry have helped advance the environmental laboratory program of the University of Wyoming's College of Engineering.

According to Prof. Robert L. Sutherland, head of the department of mechanical engineering, the gifts include a Model TEMC automatic sine wave control system from MB Electronics, 10 sets of vibration testing manuals, used in class work, from Ling Electronics, and two accelerometers and associated circuit elements and connectors from Endevco Corporation's university equipment program.

British Also Elect

The Society of Environmental Engineers, of England, also held elections last Spring. Victor C. P. Weake, of Derritron Ltd., founder of the two-year-old organization, was elected the first president. He was formerly chairman.

Others named for the current year are: Chairman, F. I. L. Knowles; secretary, K. Mason, and public relations officer, C. R. Rex-Hassan.

Hahn

Minteer

N.Y., Coast Chapters Elect Hahn, Minteer

Richard F. Hahn, manager of the Engineering department of U. S. Testing Company, Hoboken, N. J., is the new chairman of the New York Metropolitan chapter of IES. He succeeds Norman A. Ponge, of Space-Tronics, Inc. A charter member of the Chicago chapter, Hahn was with Cook Electric and Webcor prior to joining U. S. Testing.

Also elected by the N. Y. chapter were:

Carmine J. Colaluca, Republic Aviation Corp., vice chairman; Frank Culmone, Fairchild Camera and Instrument Company, secretary-treasurer; Ponge, national director, and the following chapter directors: Carl Hannemann, Loral Electronics, Inc.; Russell Hoffman, Hazeltine Electronics, Inc.; Jesse Markson, E. R. A. Associates; John Sexton, Arma Corporation; Robert Tucker, U. S. Testing, and Lyle Webster, Sperry Gyroscope.

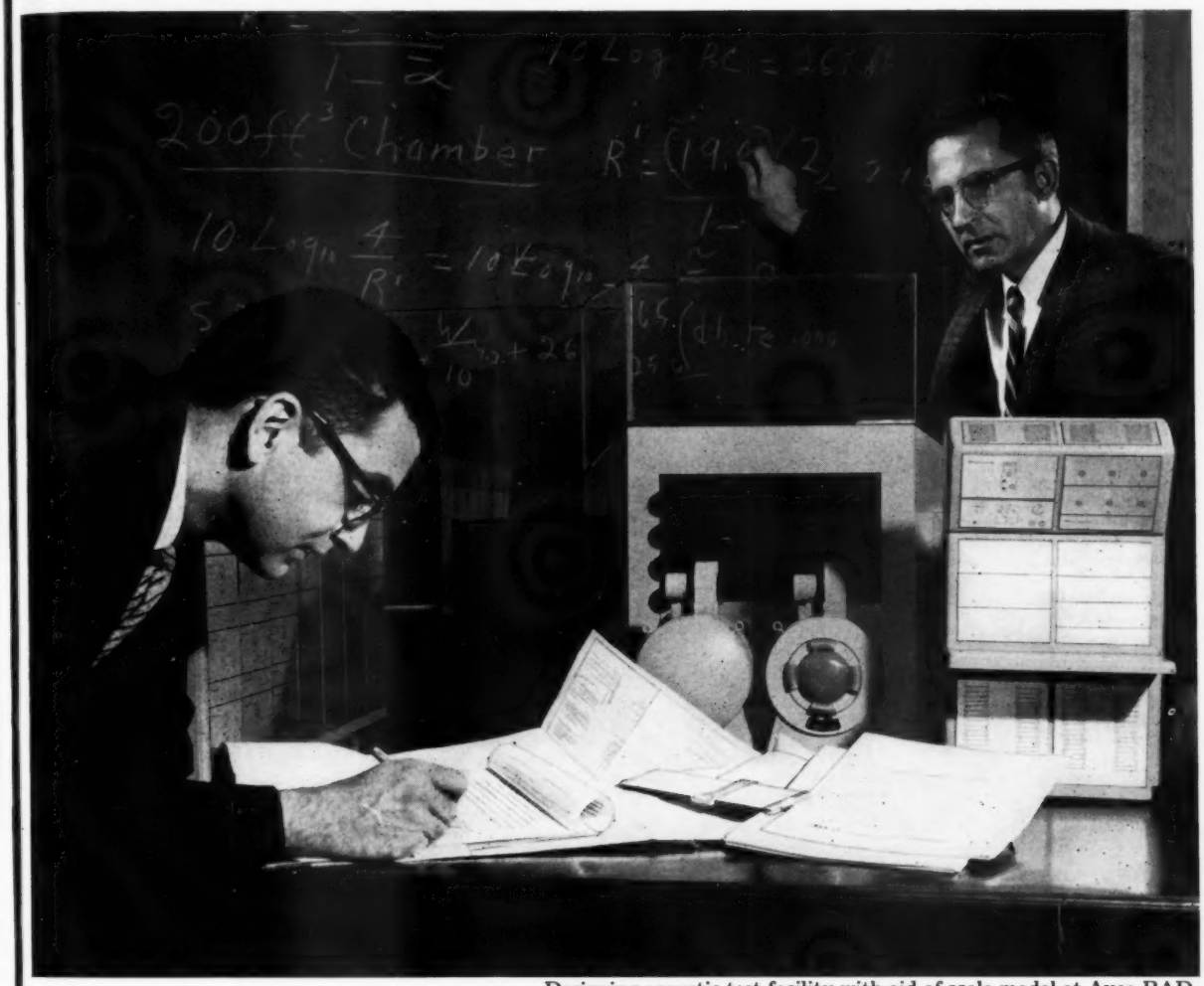
Succeeds Shaidnagle

Bruce Minteer, national field sales manager for Endevco Corporation, Pasadena, Calif., has been elected president of the Los Angeles chapter of IES. He succeeds Robert H. Shaidnagle, of Mar-Tec Electronics, Inc.

Minteer is also electronics advisor to the firm of Ernest Loen, management consultants, in Los Angeles. A native of Chicago, he is a graduate of Beloit College and has done advanced work in electronics and engineering. With his wife and three sons, he lives in Monrovia, Calif.

Cryogenics Papers

Sixty-five technical papers presented at the 1960 Cryogenic Engineering Conference at the University of Colorado have been published by Plenum Press, New York. The price is $15.



Designing acoustic test facility with aid of scale model at Avco RAD.

Flexible sound systems designed to order

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Whatever your needs for high-intensity sound, Avco experience and design capabilities reduce system complexities, cut costs, provide flexibility for growth to meet requirements.

For example, Avco recently developed an acoustic test facility for Sud Aviation to simulate rocket engine noise at its research center in Cannes, France. In this system, a single 3-KW Avco Noise Generator Type AG-012 replaces more than a score of conventional loudspeakers. Result: The Sud Aviation system produces up to 156 decibels in a 200-cubic-foot chamber, thereby permitting tests of specimens up to 20 cubic feet.

Advantages of Avco Systems:

- **Permit random-noise and sinusoidal testing over broad frequency spectrum of 20 to 10,000 cycles.**
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- **Produce true simulation of random acoustic noise environment—peaks over three times the rms level.**
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Heart of the Avco Systems is the AG-012 Acoustic Noise Generator. It will reduce system complexity and maintenance, provide more compact enclosure design, raise ratio of acoustic energy per square unit of chamber wall area, thereby producing higher sound pressure levels with less equipment.

Avco offers complete services in the design and construction of reverberation chambers and other components of noise testing systems.

Free systems analysis

Your local Avco representative has a complete workbook describing Avco systems. Just tell him the sample size you want to test, the sound pressure levels you want to achieve, and he will outline the proper system for you. Offices throughout continental United States and the world. Or write: *Industrial Products Subdivision, Research and Advanced Development Division, Avco Corporation, Wilmington, Mass.*

AVCO

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At Another Show

The IRE Show in New York's Coliseum last March drew a number of environmental specialists. Among them were two New England exhibitors, MB Electronics (above) and the Acton Laboratories (below). MB featured its vibration test systems. At the Acton display, Arthur A. Briggs (left) liaison engineer, discussed new space simulation facilities with an associate, Robert Griffin. Acton underwent a major expansion program last year.

Probe Suggests Density of Outer Space May Be As Low as 10 Atoms per cc

New calculations suggest that interplanetary space may have only one one-thousandth the density indicated by several currently popular theories—as low as 10 atoms per cc except during solar eruptions.

The new estimate, reported by the Naval Research Laboratory, is based on measurements made last November during an Aerobee-Hi rocket flight over New Mexico. It tends to confirm work during the '57-'58 International Geophysical Year by British and Soviet scientists, who calculated a maximum density of about 50 electrons per cc. An atom must contain at least one electron.

Such theories as those that hold that the earth's orbit lies within the sun's corona and that solar gas flows into space at a steady and fairly rapid rate may now have to be reexamined. From these theories estimates have been made that up to 10,000 atoms per cc were to be found in interplanetary space.

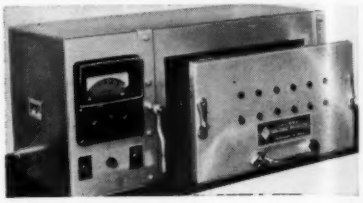
Comets' Tails Wrong?

The fact that comets' tails always point away from the sun is one point of evidence behind the strong-flow-of-solar-rays theory. It has been felt that a flow of sufficient magnitude to produce this effect on a comet's tail would result in a relatively high concentration of gas in space. According to NRL's Dr. Herbert Friedman, however, the alignment of a comet's tail could be caused by the pressure of solar energy rather than by the impact of solar particles.

Remote interstellar space is believed to have a density of as little as 1 atom per cc.

Last Fall's measurements were made by photocells sensitive to helium glow.

New for Testing

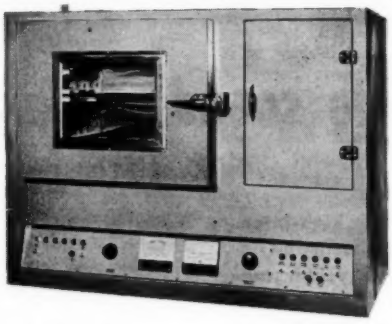


For bench-top operation, Cincinnati Sub-Zero Products introduced the Ultratemp/600 at the IES Show. Temp range in ½-cu. ft. work space is −100° to +500°F, with 5-minute pulldown and 30-minute warmup. Range of Ultratemp/800 is −320° to +500°F. (For more info circle EQ RSC "O.") Other IES pictures, Pages 24-26.

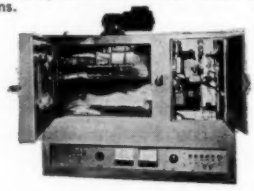
Reliable, Consistent Test Results With . . .

OREC 0300 ***Automatically Controlled Ozone Test Chambers***

. . . certain factors associated with manual ozone measurement and control suggested the need for Automatically Controlled Ozone Test Chambers . . .



Orec 0300 Series employ an *electronic-chemical loop feed back servo system to achieve and precisely maintain chamber ozone concentrations.



Orec 0300 with Dynamic Stretching Apparatus.
* patent pending

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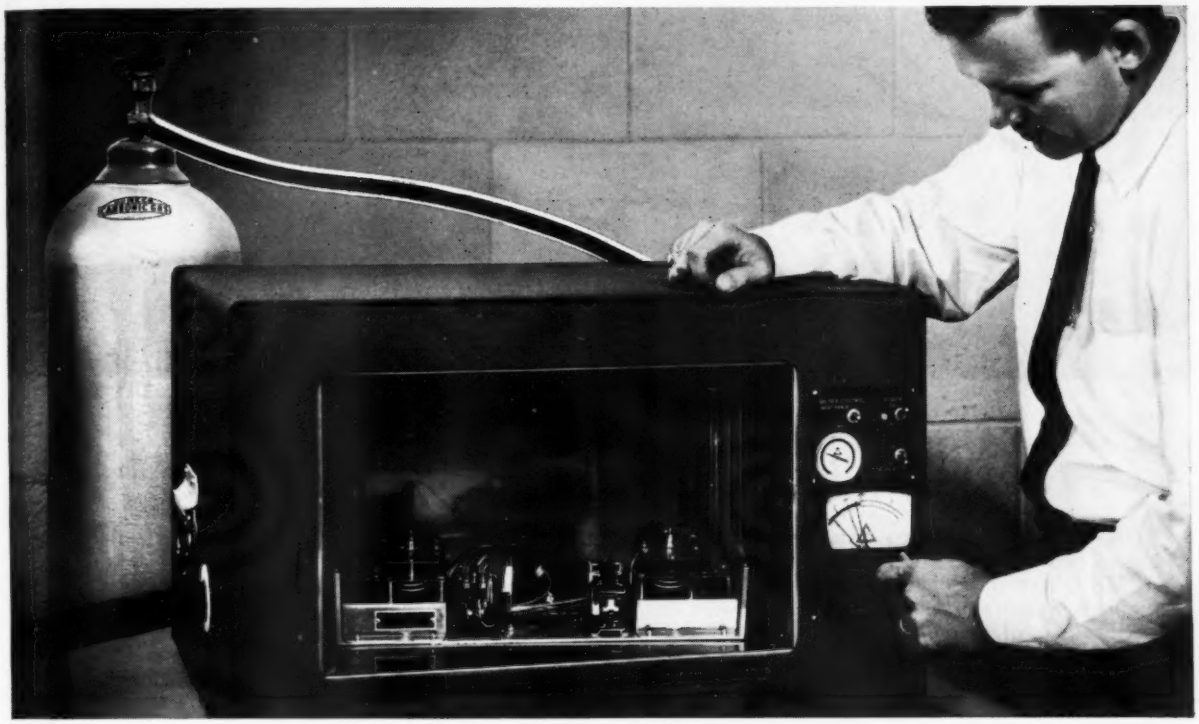

SAVE WITH PURECO CO_2 "BLAST COLD"

Extremely close tolerances possible

Test chamber temperatures with extremely close tolerances can now be easily achieved with the Pureco CO_2 "*Blast Cold*" process. Tolerances of $\pm\frac{1}{2}°$ are possible! This close control is obtainable by using specially designed cabinets and controls (as illustrated) and Pureco CO_2. Such pinpoint accuracy makes Pureco CO_2 liquid ideal for shock testing and hot and cold cycle testing.

Quick test chamber pull-down

This same simple Pureco CO_2 liquid direct injection process also provides refrigeration of unlimited capacity instantly . . . any time . . . anywhere. The Pureco CO_2 "*Blast Cold*" process can reduce temperatures from plus 500°F to —100°F in minutes. A minimum of mechanical devices in the system results in a high degree of reliability . . . there is virtually no danger of costly failures in the middle of a test.

Portable units now available

Since many environmental testing jobs are scattered around in plants, Pureco now supplies, in addition to cylinders, portable CO_2 bulk liquid units of 1000 lbs. capacity, as well as fixed units up to 60 tons or more capacity. Capital investment and maintenance costs are low . . . CO_2 receivers are normally supplied and maintained by Pure Carbonic on the customer's premises.

Have a trial "Blast Cold" demonstration

Pureco would like to demonstrate "*Blast Cold*" to you at *your* plant under *your* working conditions with no cost to you. Call your local Pureco representative or write:

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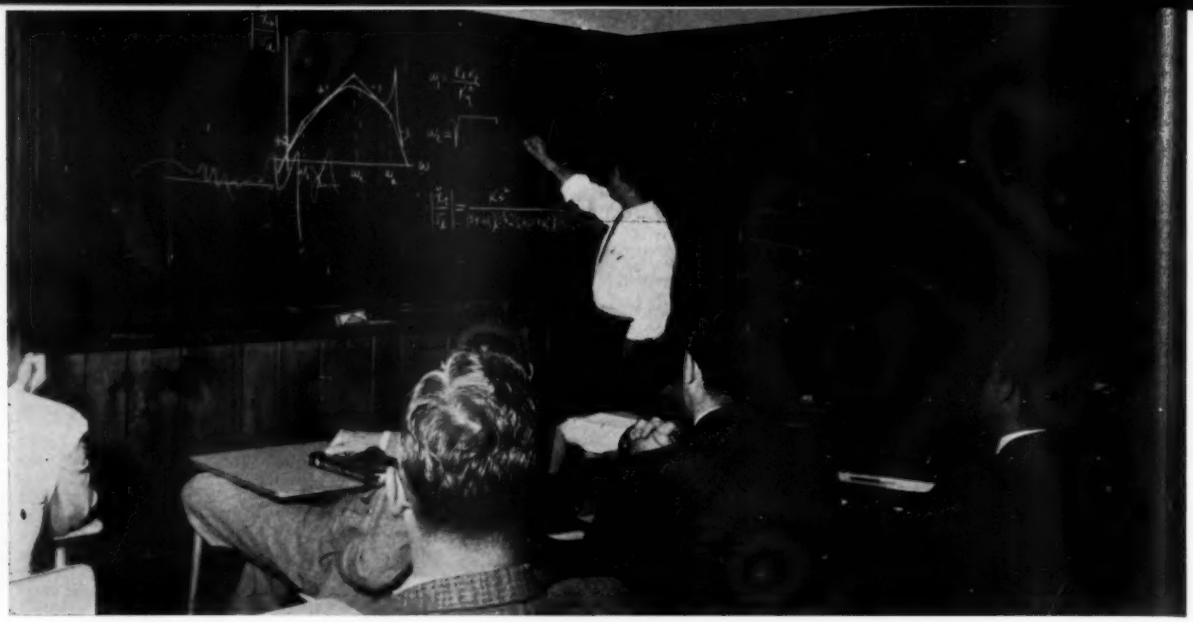


Random Signal Theory Definitions

(Herewith, Environmental Quarterly presents the first of two exclusive articles based on a high spot of MB Electronics' popular series of vibration seminars. Because understanding the language and specifications of random vibration testing, the design of electrical apparatus used to drive the shaker and the basic techniques of random signal measurement require a background in random signal theory, this first article is devoted to definitions of random signal terms. The second article "Random Noise Generation and Measurement," will appear in the October issue.)

Random Time Functions

A typical random time function is shown in Figure 1. A voltage is depicted, but the curve might represent a random current or a random acceleration with equal validity. Characteristic of the random time function is the erratic, aperiodic oscillatory behavior shown. The sine wave, on the other hand, exhibits a smooth, periodic behavior. A simple equation cannot be written for the random voltage.

For a pure sine wave, a knowledge of the value at any past time, together with the rms value and frequency, is sufficient information to predict the exact value at any future time. For a random signal, however, this is not true. A knowledge of the past history and the value of the signal at any particular time enables one to predict only the most probable value of the signal at any future instant. An exact prediction is impossible.

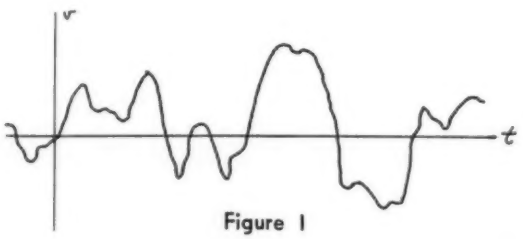


Figure 1

From the foregoing, it can be seen that the description of random phenomena employs aspects of statistics or probability theory. This approach is necessary because the behavior of the random signal is erratic and not precisely predictable. The use of probability theory is also suggested when the sources of random signals are examined.

Random Sources

Random voltage fluctuations in electrical resistances result from the thermal agitation of electrons within the resistors. Atmospheric turbulence produces random vibration in airframes because of the complicated interaction of small pockets of air with the surfaces of the airframe.

Random phenomena, in general, are caused by the cumulative effect of a great many stimuli acting simultaneously. The number of stimuli is so large, and the interactions between the stimuli are so complicated, that any attempt to describe behavior by a set of casual equations would be futile. Thus, the attempt at exact prediction of behavior is abandoned in favor of the probability approach, involving average behavior.

Sine-Random Similarities

The preceding discussion has emphasized the differences between sinusoidal signals and random signals. It should be pointed out, however, that there are analogous similarities in the methods for describing the properties of each type of signal.

First, the description of a random signal must contain information about the amplitude characteristics of the signal. Some sort of amplitude description is possible simply because one notices that some random signals are larger than others. This description is not a single number, as is the case for a sinusoid, but involves specifying the probability of the occurrence of the signal in different amplitude intervals.

Second, the description must also contain information concerning the frequency characteristics of the random

signal. To be sure, the up-and-down motion of the voltage in Figure 1 is not periodic, but some signals exhibit a more frequent up-and-down motion than do others. The description of the random signal in the frequency domain does not involve a single number, as does the description for a sine wave. The "power" of a random time function is not concentrated at any one frequency, but is spread over a band of frequencies.

Amplitude Description—Probability Density Functions

It is impossible to describe the amplitude characteristics of a random process by a single number. Instead, an amplitude "probability density function" is employed. A typical density function is shown in Figure 2. The independent variable is naturally the value of the random variable.

The area under the density function **p(v)** in any amplitude interval specifies the probability for finding the signal in that particular interval. As would be expected, the region of high probability of signal occurence lies near the maximum value of **p(v)**.

Gaussian Function

A very comon probability density function is the normal or gaussian function shown in Figure 3. The gaussian density function is symmetrical about the mean value m and has a standard deviation equal to (sigma). The standard deviation determines the width of the density function in the vicinity of the peak. For analysis dealing with the complex motion system, the mean values of the random variables are either zero or may be neglected. In these cases, the standard deviation becomes the rms value of the variable.

Due to the fact that the gaussian density function always has a positive value, extremely high signal values may be observed for a truly gaussian signal. In other words, the amplitude of a truly gaussian random function is not limited, as is the amplitude of a sinusoid. However, the probability of the occurrence of very high peaks becomes vanishingly small for increasing signal amplitude.

Figure 2

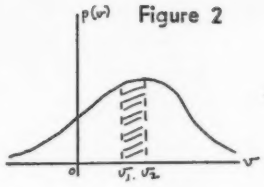


Figure 3

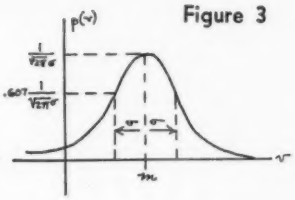
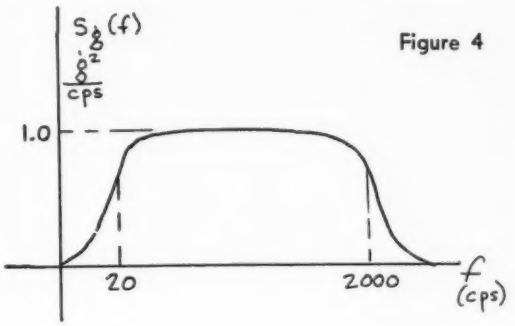


Figure 4



Gaussian Limitations

Practically speaking, no actual random time function is truly gaussian, simply because signals are always processed through devices which are approximately linear over a limited range only. Once the limited linear range of operation is exceeded, saturation of some sort is evident, and the gaussian character of the noise is

Vibration Education a Necessity as Test Function Expands

by WAYNE TUSTIN, Manager, Technical Services, MB Electronics

Despite the highly automated nature of today's environmental test equipment, the true effectiveness of these systems depends in large measure on the men who program and operate them.

Tustin

Because practical applications of environmental testing have progressed rapidly since the end of World War II, a vital need has arisen to disseminate basic information to newer environmental engineers. Most college courses are not now geared to teach the practical aspects of the subject. Although colleges are rapidly changing curriculums to meet this growing need, industry has assumed much of the responsibility of educating the environmental engineer.

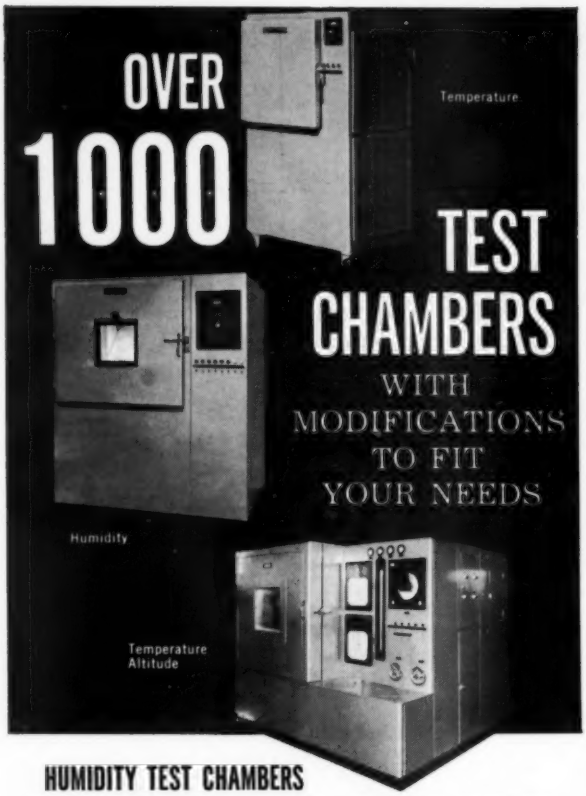
Technical seminars sponsored by industry are an accepted practice today. That they have succeeded in a variety of fields is proof they are filling a real and not an imagined need. This has been true for industry's first comprehensive seminar series on vibration testing.

Since June of 1959, just two years ago, more than 350 engineers and technicians from the nation's leading missile, aircraft and electronics firms have attended MB Electronics' vibration seminars at the expense of their companies.

The first course, "Theory and Design of Complex Motion Vibration Testing Equipment," was designed by MB to provide current information on techniques and theory in a highly specialized and rapidly developing field. The ten-day seminar was to be repeated as long as there was a demand for it. Two years later, it is still being offered and has been joined by courses on fixture design, basic vibration theory and equipment operation and maintenance.

The seminars are restricted to between 10 and 15 students to maximize teaching efficiency, and they are directed primarily at engineers who program and operate test systems. A special course on operation and maintenance is directed at technicians who operate and maintain the systems.

Seminars consist of classroom work and laboratory practice. The material presented here is an excerpt on random motion theory and signal measurement presented as a part of the original seminar on the theory and design of complex motion systems. It is taken from the course text prepared by Dr. Theron Usher, Jr., assistant professor of electrical engineering at Yale University and Charles E. Maki, who was MB's chief development engineer, accessories, when the text was prepared.



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destroyed. However, for calculating purposes, a random time function may be considered to be essentially gaussian if saturating effects take place at a level which is several times the rms value of the function.

In the field of complex motion vibration testing, the usual specification indicating the adequate character of the random acceleration produced by a system is that the system must produce peak accelerations which are at least three times the rms value. This would imply that the probability density function would be reasonably gaussian to three times the rms value. A truly gaussian random variable exceeds these positive and negative limits with a probability of only 2.7×10^{-3}. However, a quantitative specification indicating how close the measured density function must conform to the gaussian has not yet been advanced, a condition probably due to a lack of measurement devices and techniques.

Frequency Description—Power Spectral Density

Previously, it was noted that the signal "power" associated with a random time function at any discrete frequency or set of discrete frequencies is zero due to the aperiodic behavior. However, the signal "power" associated with a frequency band is positive and may vary greatly from band to band.

To provide a quantitative means of describing the frequency characteristics, the amount of "power" associated with a fixed frequency bandwidth (usually 1 cps or 1 rad/sec) is specified as a function of frequency. The dimensions of any particular "spectral density function" are given in terms of the square of the units for the random variable divided by the unit bandwidth.

For example, the spectral density for a random acceleration has the dimensions g^2/cps. The word "power" is somewhat of a misnomer; it can be explained by referring to the fact that the "power" spectral density for a voltage would be actual power (watts) per cps, if the random voltage were impressed across a one ohm resistor. The mathematical derivation of the concept is fairly involved and is omitted here.

Typical Spectral Density Function

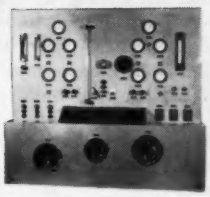
A typical spectral density function for complex motion testing is shown in Figure 4. The figure depicts a nearly constant accleration spectral density between the frequencies of 20 and 2000 cps. Outside this band the spectral density decreases rapidly.

The average "power" or mean square value associated with a certain frequency band is the area under the spectral density function in that frequency band. Thus, the mean square value for the entire random time function is simply the integral of the function between zero and infinite frequency.

This material on the nature of the random signal, the "probability density function" or amplitude description and the "power spectral density function" or frequency description could be supplemented by a discussion of various modifications of a random time function. Suffice to say that, as in any physical system, properties of a random signal are altered by processing through various physical devices and filters.

The general problem that arises is that of determining the properties of the signal at the output of the device. The problem has been solved for special cases including the linear, frequency-sensitive device, commonly called a filter, and the non-linear, amplitude-sensitive device.

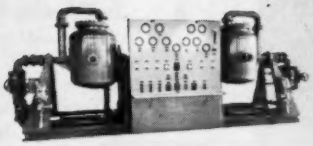
In general, determination of the amplitude probability density function for the linear device is far more difficult than determination of spectral density. The reverse is true for the non-linear device. #



FUEL VALVE TEST STAND

. . . designed to simulate an aircraft fuel tank for test and check-out of fuel valves of Republic F-105 fuel system.

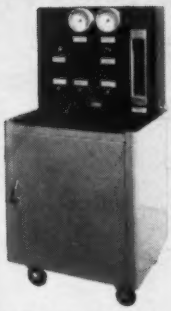
- Electrical equipment completely explosive proof to Underwriter's code
- 1000 gpm output @ 125 psi
- 10 micron filtration throughout
- Temp. control to within ±2°F . . . range 80° to 120°F
- High pressure boost system to 1500 psi @ 1½ gpm
- Turbine type flow meters with digital readout and flow totalizers



FUEL PUMP TEST STAND

. . . testing electrically driven fuel pumps under simulated in-flight attitudes and positions.

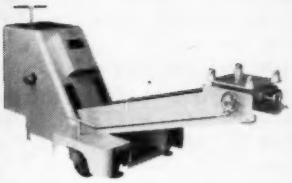
- 400 gpm @ 125 psi
- 10 micron filtration throughout
- Explosion proof electrical circuit
- Two complete separate circuits for endurance life tests, constant production tests
- Tanks rotate 360° automatically for complete attitude testing
- Temp. control to ±2°F, range 80° to 120°F
- Supplied with ac/dc generator, 600 amps, dc; 20 kva on ac section, remotely located.
- Meters read power consumption of pump under all conditions



AIR CONDITIONING TEST STAND

. . . mobile unit capable of measuring volume and pressure outputs of jet airliner air conditioning systems.

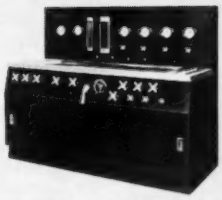
- Flow meter reads .1 to 1.0 lbs/min. air flow
- Shop-air operated @ 100 psi
- Filtered air: 10 microns



BOMB RACK

. . . hydraulic missile or bomb loader capable of lifting up to 1000 lbs.

- Operated by push-button remote station; automatically reeled out for close-in operation
- Three-positioning handles for close-in adjustment 6" fore and aft, 6" left and right, 5° tilt movements
- Wheels have separate steering handles and wheel locks; can be moved sidewards
- Table rotates 360°; locks every 10°
- Electrically powered; hydraulic lifts



HYDRAULIC COMPONENTS TEST STAND

. . . low-priced, high-quality UCON* test stand.

- Four way selector valve for directional flow cycling
- Stainless steel tubing and drain pan
- Flow: 0-20 gpm @ 5000 psi; Pressure: 0-5000 psi
- Automatic temp. control: 80°F to 350°F, ±2°
- Hydrostatic pressure: 10,000 psi
- Fluid Filtration: 10 microns
- Flow Meters: 0-5 gpm, 0-20 gpm ±1%
- Dimensions: 84" long, 35" deep, 64" high

**Highly corrosive water based hydraulic fluid.*

Precision Test & Ground Support Equipment

. . . CUSTOM TAILORED TO YOUR SPECIFICATIONS

Whether your equipment problem is ground servicing, system checkout or testing . . . on hydraulic, pneumatic or electrical systems or components . . . of aircraft, missiles or spacecraft . . . for military or commercial use . . . to conform to specifications or designed to your particular requirements . . . AEROTEST's Product Engineering Division is at your service, prepared to take your project from the preliminary design concept through engineering development and manufacturing to on-time delivery of a reliability-proven quality product.

Areas of interest which illustrate the scope of the Product Engineering Division's capabilities:

- Hydraulic, Pneumatic, Electronic Systems, Component Test Equipment and Environmental Chambers
- Training and Simulating Units
- Go-No-Go Test and Check-Out Equipment
- Control and Instrumentation Modular Consoles for Flow, Pressure and Temperature Measurement
- Aircraft and Missile Ground Servicing Equipment, incorporating Hydraulic, Pneumatic, Electronic, Electrical or Mechanical Systems

Whatever your problem, count on Aerotest to arrive at the solution and provide you with precision test and ground support equipment, custom tailored to your specifications. Write today for descriptive literature.

AEROTEST LABORATORIES, INC.

PRODUCT ENGINEERING DIVISION

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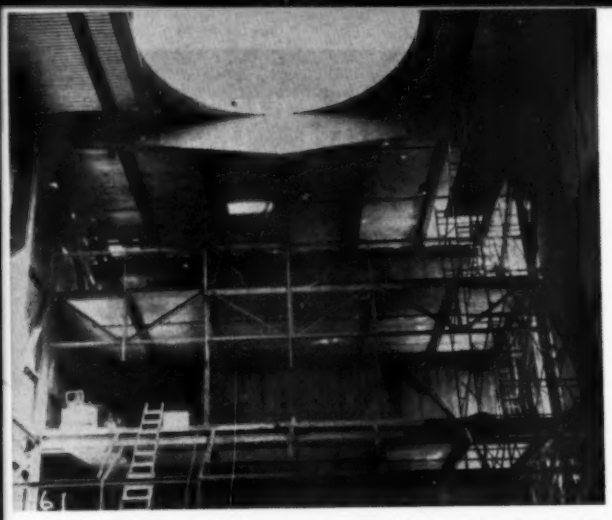
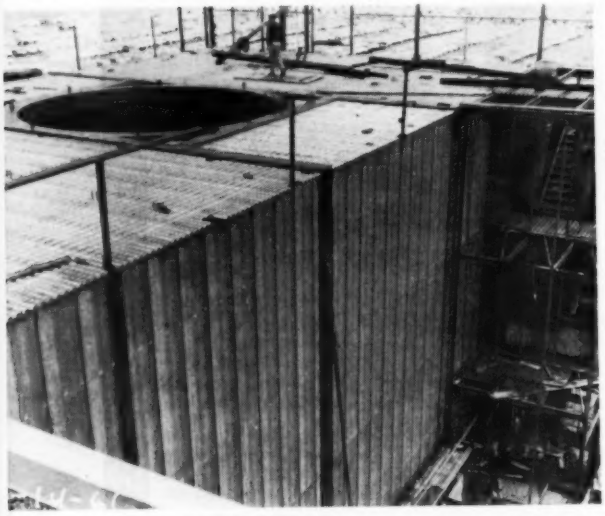
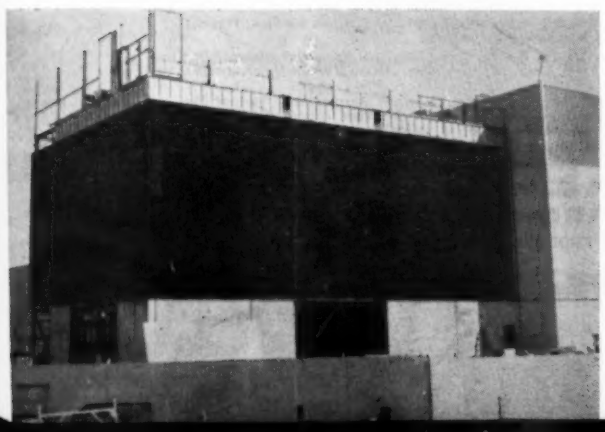


GOING UP! Progress photos show Lockheed's HIVOS, first of the major whole-vehicle orbital simulators to near completion. Chamber mounting rings are attached to the inside of the structure. Lowest section houses control console.



Slab foundations for vacuum pump pits—just a portion of the sections used to mount the powerful CVC pumps, are shown in this exterior closeup. CVC heads a HIVOS team including Tenney Engineering and Puget Sound Bridge and Drydock.

To the outsider, the lower section of the HIVOS building looked like this in late March. Insiders, however, visualized it . . .



Path of the Environment:

In Farmingdale, Long Island, last Spring, a high altitude space simulator held the center of attention during the dedication of a $14-million R & D center. Clear across the country, in Sunnyvale, Calif., final preparations were in progress for the opening of HIVOS, a $1.6-million orbital installation, this Summer. In Dallas, Princeton, Valley Forge and Ann Arbor, multi-million-dollar projects were under way in an unprecedented expansion of the Environment. Here is an Environmental Quarterly special report on major aspects of the biggest roll-back of environmental frontiers in history.

HIGH, WIDE

For the Agena, HIVOS —Highest of the High

As systems manager of the Agena satellite family, Lockheed Aircraft Corp.'s Missile and Space division has had an unusually high number of successful orbits in the Discoverer series. To perfect the Agena for its role in MIDAS (Missile Defense Alarm System) and projected lunar probes, Lockheed ordered HIVOS (High Vacuum Orbital Simulator) from a team headed by Consolidated Vacuum Corporation.

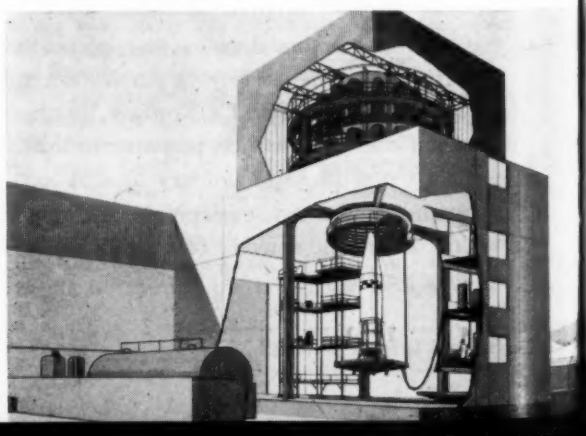
When HIVOS was originally announced, its 1 x 10^{-8} mm Hg. capability was estimated at 200 miles of altitude. Now, 1 x 10^{-8} is believed to be the equivalent of 300-350 miles.

The austenetic stainless steel chamber will measure 18 feet across on the inside, and 20 feet high, with provision for raising it to 35 feet. It will accept a test specimen 8 x 15 feet, or 10 x 32 feet when extended. To house HIVOS, a structure 90 feet tall has been attached to LMSD's satellite center building at Sunnyvale, Calif.

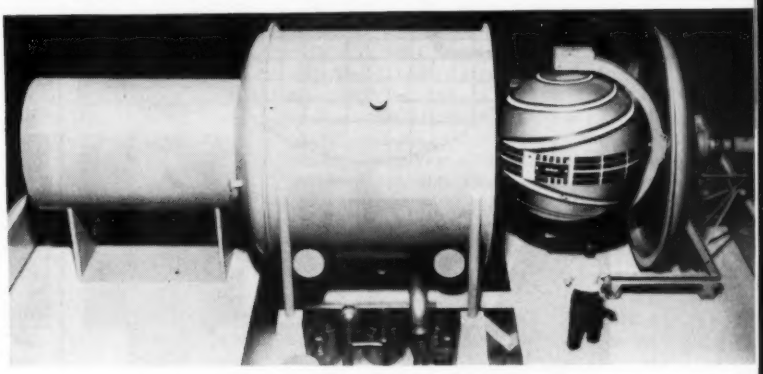
Will Not Simulate Ascent

HIVOS is specifically designed to enhance the operational reliability of a satellite system and to develop such a system for a minimum orbital life of at least one year. The objectives will be to determine mean time to failure

. . . as a 90-foot structure that would take the versatile Agena to 300 to 350 miles, higher than it ever reached without leaving earth.



SPACE ON EARTH CENTER being built by Chance Vought is nearing completion in Dallas. It features this simulator, by Tenney Engineering, with 1,100,000 feet altitude, solar spectral radiation, heat sink and giant claws to spin 8-foot objects on two axes.



...and spatial

modes of the payload and supporting equipment when subjected to orbital temperature and altitude.

HIVOS will not, therefore, simulate ascent. Such tests, it was felt, could best be performed with relatively small laboratory-type equipment designed to satisfy specific objectives.

A major project awaiting HIVOS is the study of material reliability under extreme temperature variance, with the entire vehicle tested an as integrated whole under orbital pressure. The chamber is designed to permit a vacuum of 1×10^{-8} or better, and $+500°$ to $-100°$F in four hours.

Sun and Heat Sink

To simulate heat from the sun and earth albedo, panels of quartz lamps providing up to 1,000 BTU of heat per square foot per hour will be spotted around the outer surface of the satellite. For a heat sink, walls of the chamber will be refrigerated by nitrogen at approximately 77°K. Heating and cryogenic elements are being supplied by Tenney Engineering, Inc., Union, N. J. Puget Sound Bridge and Dry Dock Co. is the structural components contractor. Consolidated Vacuum, a Consolidated Electrodynamics Corp./Bell & Howell Co. subsidiary, is supplying vacuum pumping in addition to having prime responsibility for the entire project.

Highly polished interior surfaces and a bakeout cycle will help produce the low pressure conditions required of HIVOS. Without the bakeout, the ultimate pressure of the chamber, it is estimated, would drop to approximately 1×10^{-7} mm Hg.

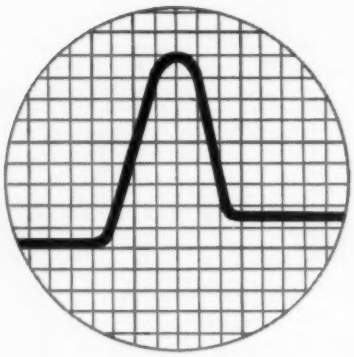
Servicing Without Interruption

Twenty-two CVC Type MC-28000, four-stage oil diffusion pumps, with Chevron-type liquid nitrogen baffles, capable of net pumping speed of 160,000 liters/sec at 1×10^{-6} mm Hg. are in the high vacuum pumping system. They are arranged symmetrically around the chamber periphery. It will be possible to remove any one of four KS-4000 diffusion-ejector pumps for servicing or replacement without jeopardizing continuous operation.

A rough pumping system will reduce chamber pressure from 760 mm Hg to 10^{-2} mm Hg within half an hour on a 70 per cent relative humidity 80°F day. All or portions of this eight-pump system may be used to back up the diffusion pumps.

Partial simulation techniques will not degrade the accuracy of HIVOS, because corrections will be made

UNIQUE FEATURE of Republic Aviation's recently dedicated complex of research laboratories at Farmingdale, L. I., is this 30-foot Tenney Engineering chamber capable of taking both men and systems to the rarified altitude of 150 miles. A member of the lab wearing a high altitude pressure suit adjusts his ventilation line inside the chamber.



MM

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DEPENDABLE operation and accurate tests can only be assured through constant research and the use of highest quality materials and workmanship. Murphy & Miller test equipment is manufactured to the highest standards with quality the prime objective. The true meaning of dependability becomes vital when it is considered than an entire production schedule often hinges upon . . . a dependable test.

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ENVIRONMENTAL TEST EQUIPMENT

600 West Taylor Street, Chicago 7, Illinois

to adjust results for departures from outer space conditions. Concentrating HIVOS on parameters of greatest significance, that is high vacuum and temperature, will also have the effect of producing greater accuracy and more reliable test data.

HIVOS will be automatically programmed and controlled. It will have low speed digital data acquisition systems to record the thermal environment as well as monitor test vehicle functioning.

William Finney, assistant director of CVC's Custom Products division, is senior engineer on the HIVOS project. Donald Hilfiker is project engineer at the scene.

Long Island's Route 110: Highway to the Heavens

Route 110, a major north-south highway that cuts across Long Island's no longer sleepy Suffolk County, was once known mainly for its gigantic drive-in motion picture theatre. Today local residents call it the route to the stars—heavenly stars, that is.

The change in emphasis stems from the dedication on April 29 of Republic Aviation Corp.'s Paul Moore Research and Development Center, a $14 million monument to the future of the skies. Among seven labs in the center, a space environment laboratory has a key position.

A giant environmental altitude simulator built by Tenney Engineering, Inc., has been installed in the lab. The 30-foot, 42-ton "space ship" will test men and complete space systems and capsules under ionospheric conditions of about 150 miles, claimed to be the highest ever achieved in so big a unit.

The cost of the chamber and its special vacuum pumps and other equipment has been put at about $500,000.

Chance Vought Constructs 'Space on Earth' Center

Probably next of the major, new environmental installations to go "on stream" will be Chance Vought Corporation's "Space on Earth" Center in Dallas. Three simulators will be featured: a space environment simulator, a manned space flight simulator and an automatic controls evaluation simulator.

The environmental simulator will be used to develop and test satellites, vehicles and systems under altitude conditions of 1×10^{-7}—about 200 miles. Capable of spinning test objects up to eight feet in diameter and 1,000 pounds in weight on two axes, the simulator will provide space thermal radiation levels and solar spectral radiation of variable flux, Earth to Mars. A black wall heat sink will be refrigerated to −320°F with liquid hydrogen.

Meteoroid Bombardment Planned

Future additions will make it possible to bombard test articles with meteoroid-like and possibly nuclear particles, according to Chance Vought.

Tenney Engineering, Inc., built the space simulator.

In the flight simulator, a pilot will be able to perform such space missions as earth orbiting and landing. He will see earth and planetary horizons and star fields as they would appear, and even experience the heat, noise and vibration of an actual vehicle.

(*Continued on page 27*)

ENVIRONMENTAL BUSINESS...

Turn Also To Page 44

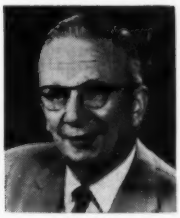
Bruskrud Elected President of EEI

Warren R. Bruskrud, president of Bemco, Inc., Pacoima, Calif., has been elected president of the Environmental Equipment Institute, trade association of equipment manufacturers. He succeeds Jack Shamroth, head of American Research Corporation, Farmington, Conn.

Bruskrud

E. S. Brown, of Standard Cabinet Company, Inc., Carlstadt, N.J., was elected vice president of the institute, and the following former presidents were selected as directors: Charles C. E. Harris, of Harris Manufacturing Co., Inc., Cambridge, Mass.; R. J. Jacobson, of Cincinnati Sub-Zero Products, Cincinnati, and Monroe Seligman, of Tenney Engineering, Inc., Union, N.J.

Brown



Harris

Jacobson

Seligman

Meeting New Challenges

In a statement to EQ, Mr. Bruskrud hailed the progress of the environmental industry during the past decade and said the nation's space efforts presaged another stage of expansion.

"Environmental equipment manufacturers," he said, "have met the increased performance requirements and are now meeting even more advanced requirements with chambers dubbed 'space simulators.'"

Future space simulation, he noted, may include duplication of cosmic radiation and meteoroid bombardment.

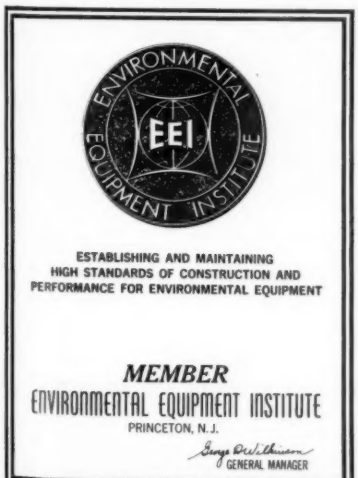
Mr. Bruskrud noted that the environmental manufacturing business is growing "at a very rapid rate," as evidenced by the new companies entering the field.

Role in Industry Ethics

"The EEI," he said, "has in the past and will in the future play an important role in furthering the environmental science and maintain ethics in this fast growing industry."

Mr. Bruskrud invited environmental equipment manufacturers seeking information about the industry and EEI membership requirements to contact Dr. George Wilkinson, general manager of the institute, at 9 Spring St., Princeton, N.J.

It was announced at the EEI meeting, held in Washington at the same time as the IES meeting, that member companies are now displaying a new EEI membership plaque in their plants. The plaque is a design duplicate of the EEI's Seal of Approval, a metal plate that can be affixed to equipment they ship. It signifies adherence to the EEI's standards of business and manufacturing procedures.



NEW PLAQUE: Members of the Environmental Equipment Institute, trade group of equipment manufacturers, are sporting this new membership plaque in their lobbies and offices. It incorporates the design of EEI's seal of approval.

Giant Vacuum Melting Furnace

One of the world's largest vacuum melting furnaces, to cost more than $100,000, will be built by Consolidated Vacuum Corp., Rochester, N. Y., for Eldorado Mining and Refining, Ltd., at Port Hope, Ontario, Canada. It will have a capacity of ingots of 3,000 to 6,000 pounds.

Liquid Carbonic Builds Plant

Liquid Carbonic division of General Dynamics Corp. is erecting a large liquid nitrogen-liquid oxygen plant in Tewksbury, Mass., to serve the New England market. It is expected to go into operation next Jan. 1.

NRC Studies 10^{-10}

National Research Corporation, Cambridge, Mass., has received two Air Force contracts totalling more than $100,000 for basic studies of materials in vacuums simulating altitudes of 500 to 600 miles.

One is an investigation of out-gassing characteristics of materials in the ultra-high vacuum of 10^{-10} mm Hg at temperatures from 80° to 800°F. The other involves comparison of the mechanical behavior of selected structural materials at the same and at above pressures.

Conrad Reports Record Activity

Conrad, Inc., Holland, Mich., environmental equipment manufacturing subsidiary of Crampton Manufacturing Co., reports that its first 1961 quarter operation showed a 38 per cent net gain over 1960. Charles Conrad said, too, that for 1961 sales activities, quotations and potential orders on space chambers and other types of equipment appear to be greater than for any previous year.

New Plant for Bemco

Bemco, Inc., manufacturer of environmental test chambers, has moved into a larger plant at 9908 San Fernando Rd., Pacoima, Calif. Expansion plans include construction of a high-bay plant for space simulation systems.

Bemco, which started operations in 1951, was formerly in a 10,000-square-foot plant in North Hollywood, Calif.

Baking Made Easy

Easy loading and unloading of the work and maximum flexibility in integrating the unit into other processing equipment is provided by doors at both ends of Model 236-H high-temp, high-vacuum baking oven by F. J. Stokes Corporation, Philadelphia. This one has 3.8 sq. ft. of usable shelf area. (For more info circle EQ RSC "L.")

A break between sessions of the Institute of Environmental Sciences and concurrent meetings of the Environmental Equipment Institute found AMERICAN RESEARCH CORP.'s Ted Augustyn, Jack Shamroth and Marty Freitag (above, l. to r.) discussing their company's many chamber designs. Shamroth retired as EEI president.

EQ's Own Tour Of the IES Show

Were you there? If you see yourself on one of these pages or not, you can get more information about any display by writing the exhibitor's name and the word "Show" on EQ's postage-free Reader Service Card.

Fritz Ehrler (l., above) discusses an item of the BEMCO, Inc., line with a prospect. On the table at right is a model of Bemco's new series of small temperature chambers, one of the many pieces of new environmental equipment unveiled to the public at the Washington show early last April. Next year's show will be in Chicago.

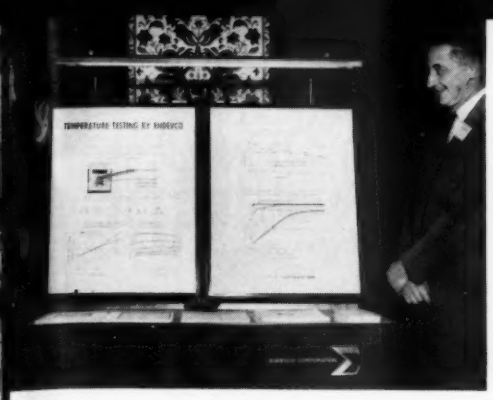
Visitors to the CONRAD, INC., booth (below) walked off with a pair of little wooden shoes, symbolic of the environmental chamber manufacturer's Holland, Mich., home. Conrad exhibited a hyper-environment simulator with capabiilties to 500,000 feet altitude.

ASSOCIATED TESTING LABORATORIES, INC., displayed Econ-O-Line temp-hum and Mark II chambers and an auxiliary vibration table with air lift. At right (l. to r.) Robert Goldsmith, ATL manager of contracts engineering, and R. T. Blough and A. G. Dubovick, both of Electric Boat, examine ATL's all-lucite salt spray chamber.

Photo at right shows (l. to r.) IBM-Endicott's Rudy J. Janasek and I. E. Rosenbarker, AEROTEST LABORATORIES' Paul Glasser and Fairchild Engine and Airplane's Arthur D. Cozewith as they discussed Aerotest's facilities. In background is panorama of the big Long Island lab.

While a visitor listened (above), Maurice Tardif (r.), field engineer of BARRY CONTROLS, explained the application of Barry's registered Rigidamp structural damping for the fiberglass electronic chassis of an ICBM nose cone. In addition to damping devices, Barry exhibited its line of Varipulse shock testing machines.

Expendable refrigerants were prominent throughout the show. PURE CARBONIC COMPANY (below), which supplies carbon dioxide as a solid, liquid or gas, exhibited a portable liquid CO_2 receiver unit and demonstrated the almost instantaneous pull-down capability of carbon dioxide by injecting a stream into the bubble-like demonstration unit in the foreground.



ENDEVCO CORPORATION'S hospitality suite was a popular oasis at the Sheraton-Park Hotel. Scene in the suite (at left) shows Hal Gilmore (left), Endevco field engineer, and Jim Rhodes, Endevco's technical services manager, examining a display headed "Temperature Testing at Endevco."

A new vibration testing concept was introduced by MB ELECTRONICS with a narrow band random system (far left in photo above) feasible for even a very small test facility. In the center is MB's Vibramatic, with ceramic-type exciters, and at right is MB Model T388 multi-filter automatic random vibration test control.

At the GULTON INDUSTRIES booth (left) are (l. to r.) Stephen Speranza, Sperry Gyroscope; Ed Berman, Gulton; Lyle Webster, Sperry; Bud Nelson, Gulton, and M. D. Nixon, Dow Chemical. Avco exhibited at Gulton's side; Environmental Quarterly's booth was across the aisle.

Colorful Displays Drew Many Visitors

Old standbys and equipment to simulate the environments of tomorrow all got close examination. If anything catches your eye, write "Show" and the exhibitor's name on EQ's Reader Service Card.

Above is the BLUE M ELECTRIC COMPANY booth in which a new MIL-202B controlled relative humidity cabinet was featured. The counter flow, bench-type unit incorporates a saturable reactor control system that operates without cam or compressor, contact switches or other moving parts that wear, burn or arc. Specifically designed for Method 106A, Steps 1-6, it also performs Method 103A, Procedure 2.

A lofty point of view was required to examine CONSOLIDATED CORPORATION'S PMC-45,000 pump (above). Other CVC items reading from the big pump at left, are: mass spectrometer leak detector; PDV-30 DriVac pump with power; PDV-300 DriVac pump; Anavac pump; Hyge and HY-6500 control panel, and constant reading type oscilloscope.

Further evidence of rapid temperature pull-down was given by LIQUID CARBONIC (below), with an actual CO_2 in-plant low temperature demonstration unit with time console. Also demonstrated was liquid nitrogen for temperatures below —150°F. In conference (l. to r.) are Liquid Carbonic's Ron A. Baselice, sales application engineer; James M. Venetucci, technical sales engineer, and Richard E. Scherf, CO_2 field salesman.

LIQUID CARBONIC
Division of GENERAL DYNAMICS
REFRIGERATION PROCESS
INPLANT LOW TEMPERATURE DEMONSTRATION UNIT
AVAILABLE NATIONALLY FOR DEMONSTRATION BY LOCAL LIQUID REPRESENTATIVES
LIQUID CARBONIC GENERAL DYNAMICS

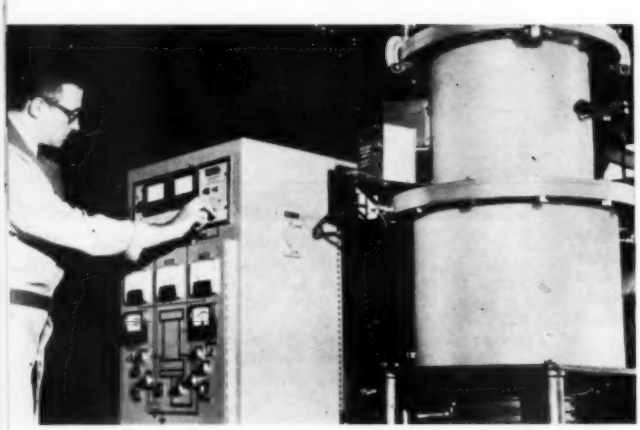
Sales Manager Douglas M. Bergen, at left in photo below, demonstrated quick pulldown of an ELECTRIC HOTPACK COMPANY, INC., temperature shock chamber to Jim Guerra, of Washington, D. C. Hotpack also displayed vacuum and forced draft ovens and humidity cabinets.

TENNEY ENGINEERING, INC.'s, orbital, environmental and acoustics exhibit drew clusters of visitors (above). William G. Dunn, manager of the acoustics division, is second from the left. Robert H. Brown, Tenney's vice president—sales, is fifth from left. A model of Tenney's orbital simulator for Chance Vought can be seen in the right foreground.

The brilliantly lighted booth (above) at a corner of the exhibition hall was that of THE STRONG ELECTRIC CORPORATION, whose president, Arthur J. Hatch (r.) led a team demonstrating the Jetarc solar radiation simulator. A blown carbon arc source, it was originally developed and produced for outdoor movie theaters.

At the head of a well-traveled aisle on the Sheraton-Park Hotel's exhibition floor, RESEARCH, INC. (above) was visited by many of the nearly 1,000 environmental professionals who attended the convention. The company featured deflection measurement and load and temperature programming.

J. G. Jellies (left in photo above) and Don W. Hohoeck, both of Automatic Electric Labs, Northlake, Ill., flank Homer Dargert, director of engineering sales of ROTOTEST LABORATORIES, INC. The equipment featured at the right is Rototest's Rotocon complex wave vibration exciter.



In the high vacuum area, an F. J. STOKES CORPORATION technician (above) demonstrated that company's Model 290 test facility, designed for reliability testing of such space-borne equipment as resistors, transistors, capacitors and sub-assemblies. The assembly includes vacuum chamber, liquid nitrogen-cooled baffle, control panel, pumping system, piping and wiring.

From abroad came Don Beechey (r. in photo at right), UNHOLTZ-DICKIE CORP.'s Canadian representative, who showed U-D's Automatic Sine System 76, which will take light loads to 10KC with minimum lateral motion, and Dial-A-Gain recording instruments to W. F. Green (c.), of Canada's Ontario Hydro, and Peter B. Reade, of the United Kingdom Atomic Energy Authority, Hants, England.

The Consensus: A Very Worthwhile Journey

Washington's cherry blossoms proved to be stiff competition, but for most convention visitors The Environment won. Any questions about it? Write "Show" and the exhibitor's name on EQ's Reader Service Card. See you next year!

WYLE LABORATORIES was one of a number of California companies to come clear cross-country to exhibit at the show. Its booth (left) featured a new liquid carbon dioxide-cooled miniature temperature chamber (on the cabinet at far left) and a 100,000 force-lb. Hydrashaker exciter head (on the turntable

HIGH, WIDE . . . AND SPATIAL

(*Continued from page 22*)

Collimated Sun Source Feature of GE Simulator

A large collimated sun source, said to be the first of its kind, is being incorporated into a huge 10^{-9} mm Hg, 20°K simulator General Electric's Missile and Space Vehicle department is erecting at Valley Forge, Pa.

The collimation will be achieved with a 22-foot mirror that will beam energy on a test vehicle but deflect all energy transmitted toward it to the cryogenic walls.

GE is spending $6 million on the simulator, as part of a $30 million space technology center. The simulator is scheduled for limited operation by the end of the year and full use by next summer.

Unique Features Claimed

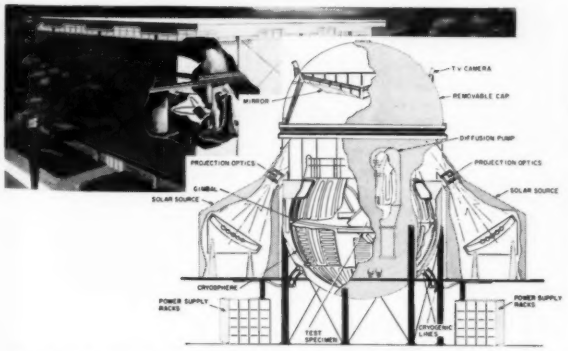
A number of other unique features are claimed by GE.

- The simulator will be 32 feet in diameter and 54 feet high.
- Like the real sun, its energy source will transmit 140 watts/sq. ft. in a uniform beam 20 feet in diameter.
- Optical components will make the sun appear to be the same distance from earth as the real sun.
- Pump-down to maximum will take four hours, with plans calling for duplicating the pressure gradient experienced in a launch.
- A test vehicle as large as 20 feet in diameter and weighing up to five tons will be accommodated for as long as 2,000 hours.

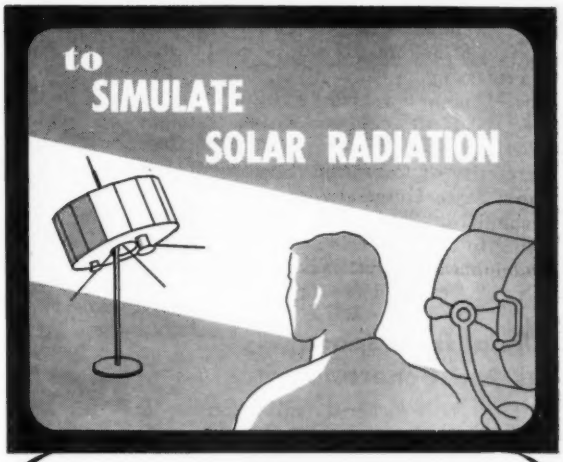
Xenon Lamp Designed

To help produce solar effects, GE's Lamp department has developed a 5kw xenon compact arc lamp. Four banks of 37 lamps each will direct energy from ultra-violet to infra-red, through optical lenses to the simulator sun mirror.

Mechanical roughing, diffusion, nitrogen and helium cryogenic pumps with a combined capacity of 70 million liters per second will be used. Under a subcontract with F. J. Stokes Corporation, Philadelphia, CryoVac, Inc., of Columbus, Ohio, is supplying heat sinks and cryo-panels, as well as helium refrigeration equipment and liquid nitrogen circulation systems. Revere Copper's aluminum Tube-In-Strip is being used. Some 250,000



ONE OF THE MOST COSTLY of the new generation of environmental installations going up around the country is General Electric's at Valley Forge, Pa. The schematic is superimposed on an artist's rendering of the $6 million simulator as the public will see it.



To develop and to test space vehicle components, the best sources of energy are GENARCO high intensity carbon arc lamps because they have the same spectral energy distribution as the sun light above earth's atmosphere. Quartz condensers or first surface reflectors are used to collimate the light. For each problem we have a suitable solution. Contact us:

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gallons of liquid nitrogen and three million standard cubic feet of helium gas will be used daily for heat sink and outgassing.

One of the first vehicles scheduled for test will be the Project Advent communication satellite on which MSVD is working.

University of California, Spectrolab, Inc., and Pennsylvania State University contributed to the design of the simulator. The 100-foot square and 88-foot high building to house it was designed by Vincent G. Kling, Philadelphia architect. Jackson and Moreland, Inc., engineers of Boston, have designed facility services.

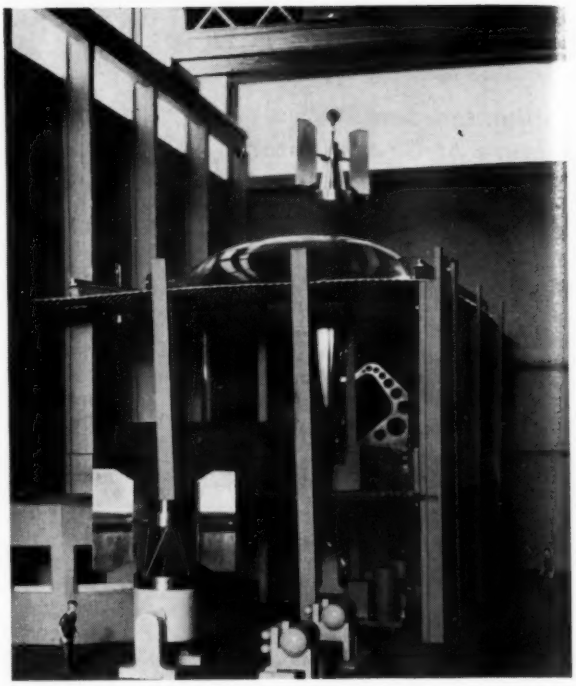
A Signal from Space Cues 2nd Generation

A Tiros II weather satellite, four months in orbit, flashed a signal to its birthplace in Princeton, N. J., last March 23 for the environmental testing of its successors.

The signal set off an explosion that broke ground for RCA Astro-Electronics division's new space environment center. Contractors for the multi-million dollar center, designed for "the larger second-generation space projects now in development," include Tenney Engineering, Inc., MB Electronics and another RCA group, the Electron Tube division. Major Defense Systems, RCA Defense Electronic Products, is general contractor, and Wigton-Abbott Corporation, Plainfield, N. J., is the architect and builder.

Scheduled to go into operation next December, the facility will subject completely assembled satellites and space vehicles to shock, vibration, vacuum, temperature and magnetic conditions.

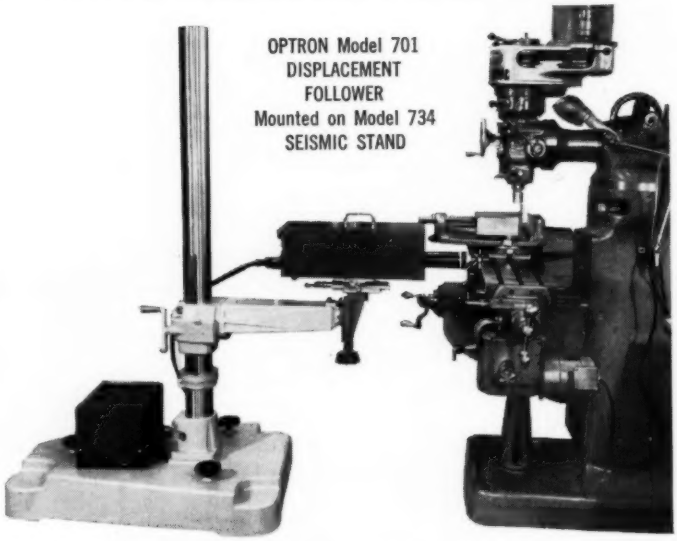
An eight-story tall building will house a 32-foot by 32-foot thermal vacuum chamber providing 20 by 26 feet of interior working space. It will provide the low pressure equivalent of "several hundred" miles of altitude at temperatures from −100° to +250°F for as long as



IN SCALE MODEL, the outer space environment center RCA is erecting at Princeton, N. J., is dominated by its large cylindrical vacuum chamber. A satellite model is being loaded from above. Note vibrator in foreground.

OPTRON Model 701 DISPLACEMENT FOLLOWER

Measures vibration of mill table or any other moving object without making physical contact. Response is flat to 3 KC. Displacement range 12 microinches (.000012") to 2 inches. Displacement appears as peak to peak voltage on readout voltmeter or oscilloscope, the latter also displaying the waveform of the motion.



OPTRON Model 701 DISPLACEMENT FOLLOWER Mounted on Model 734 SEISMIC STAND

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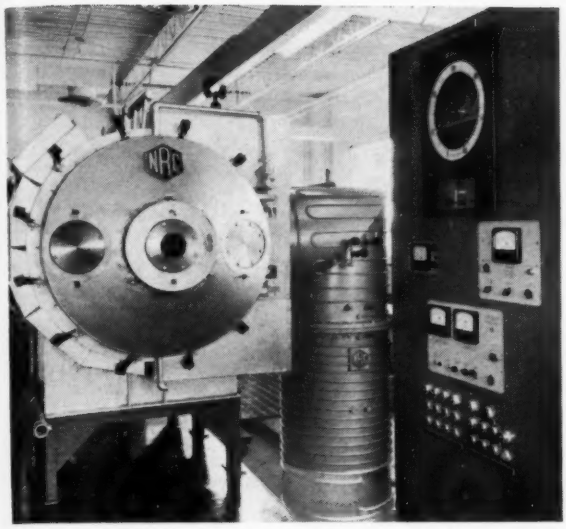

FOUR BY EIGHT feet of outer space (1 x 10^{-8} mm Hg.) is supplied to Bendix in Ann Arbor by this NRC equipment, which has been working since March. A 20' x 30' simulator with NRC pumping is scheduled for completion later this year.

three months.

The Electron Tube division's Industrial Tube Products department is responsible for the vacuum chamber and its pumping system. Tenney will provide thermal and control and monitoring systems as well as a separate 14 x 14 x 17-foot thermal-humidity chamber.

The vibration system being supplied by MB includes a high-energy, oil-cooled exciter with extensive associated amplifier and control circuits. Test loads—complete satellites or vehicles—will be vibrated with a force of up to 14 tons from 5 to 2,000 cycles per second. Provision is being made for a second shaker to operate in tandem as heavier payloads are developed.

Bendix' Goal: Dress Rehearsal for Space

At Ann Arbor, Mich., the Bendix Systems division is pushing to completion a whole-vehicle vacuum chamber and other additions to its environmental laboratory. The goal is full operation by year's end of what will be a $10 million facility for "dress rehearsal" for space.

The space simulator, housed in a 10,000-foot addition to the Ann Arbor laboratory, will measure 20 x 30 feet and will have a capability of 5 x 10^{-7} mm Hg. Chicago Bridge and Iron Company is prime contractor, with National Research Corporation, Cambridge, Mass., subcontractor for the pumping system. Eight oil diffusion pumps will be used.

NRC was prime contractor on a 47 x 100-inch auxiliary space chamber, capable of 1 x 10^{-8}, that went into operation at Bendix last March. Three still smaller units, each 18 x 30 inches and capable of 2 x 10^{-7}, round out Bendix' space equipment. Liquid nitrogen heat sinks characterize all.

Thirty Access Ports

Carbon arc and infrared lamps will simulate solar energy in the biggest chamber, with quartz lenses for ultra-violet radiation. There will be 30 access ports for probes, instruments and vibration exciters.

The lab's major vibration equipment will be a 25,000 to 30,000 pound-force shaker with 5 to 2,000 cycle per second frequency range. Capable of both sinusoidal and random vibration, it is due to become operational in early Fall. The lab also will have a 1,200 pound-force

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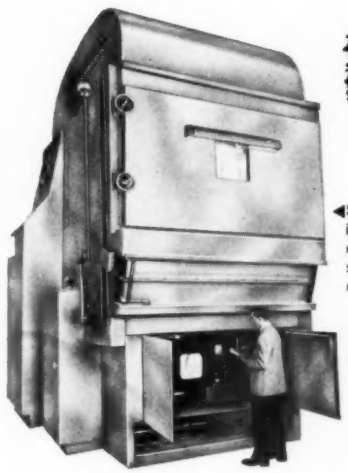

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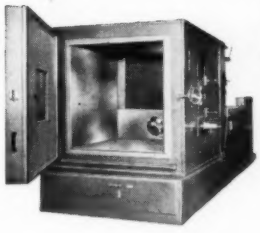

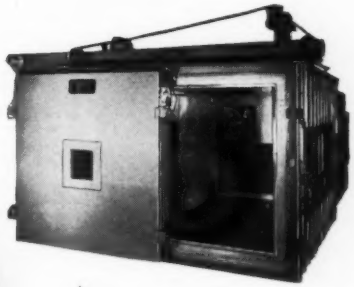

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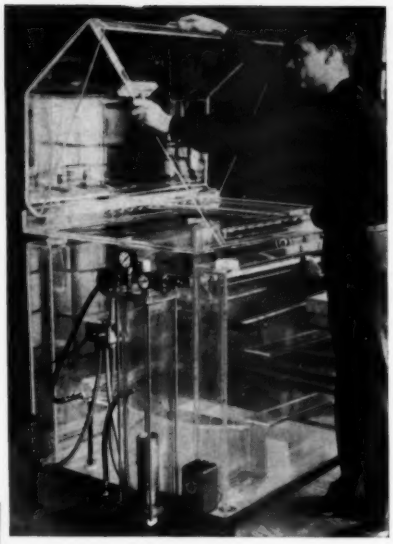

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Highest Uniform Accuracy of Test Results, Over-All Visibility at Lower Cost! Preferred by those who set the standards. Singleton Fusion-Welded "H-T Plexiglas" (above), Lined Steel and Lined Stainless (left). Sizes, types to suit.

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Magnetic density on the table top of the new UNHOLTZ-DICKIE VLG 82 vibration test system is less than two gauss when operated at full rated force of 1200 pounds. Gauss levels lower with reduced force or degaussing coils. Low gauss is a standard feature on the VLG-82. So is the rugged suspension system that assures minimum lateral motion and acceleration waveform distortion. The complete system for automatic sine operation — shaker, amplifier, control console and all interconnections — is $16,980 FOB Hamden, Connecticut.

Write for typical acceleration waveform distortion and cross-talk curves, or see a live demonstration. Then compare.

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vibrator with 5 to 3,000 cps range, a multi-environment walk-in chamber and shock and acceleration equipment.

The optical system will include 150 compact arc mercury xenon lamps, each with 16-inch reflector and using 2½KW of power. Simulated solar energy will be delivered to the spacecraft in a collimated beam through a complex series of parabolic and hyperbolic mirrors. Controlled intensities will permit study of solar effects on a vehicle as close to the sun as Venus and as distant as Mars.

Three-Stage Pull-Down

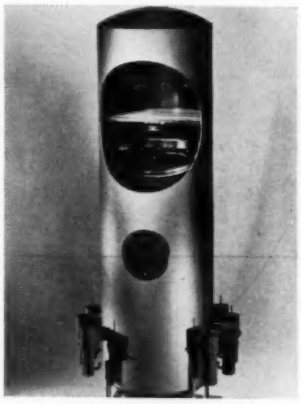
Seven giant compressors ordinarily used for JPL's supersonic tunnel will be used in the first pump-down stage. Then a roughing system of vacuum blowers and roots vacuum pumps will be called into play, and finally ten huge CVC PMC-50,000 oil diffusion pumps.

The heat sink will consist of 200 aluminum plates cooled to −320°F with liquid nitrogen.

Twelve portholes will permit visual observation of the vehicle under test, which may last three months to a year. A vibration unit may be introduced later.

Latest Contract Award —JPL Job Goes to CVC

Consolidatd Vacuum Corporation, builder of HIVOS, this week announced receipt of a $4 million contract for a new space environment simulator at Cal Tech's Jet Propulsion Laboratory. It will feature an extremely advanced sun source with an optical system designed by Bausch and Lomb.



Model of JPL's proposed "Tower of Space," the contract for which has just been announced.

Ray Zoppoth, senior CVC engineer on the project, described the simulator as a cylindrical, stainless steel tower 80 feet, four inches tall and 27 feet in diameter. A 47 x 25-foot lower section will comprise the vacuum area; the upper part will contain the solar simulation unit.

CVC said Pittsburgh-Des Moines Steel will fabricate the vacuum chamber and erect the entire facility; Aetron division of Aerojet is to provide instrumentation, external cryogenics and building design, and Tenney Engineering, Inc., internal cryogenics and power system for lights.

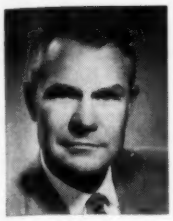
Mariner A First in Line

The first vehicle scheduled for testing in the 250-mile JPL chamber is the Mariner A, half-ton spacecraft designed for the Venus shot. With its solar panels extended, the Mariner A stands eight feet high and is 19 feet across.

Edward Perkins, director of custom products at CVC, said that he knew of no other comparable chamber of the size in existence.

People You Know...

CHANGING ENVIRONMENTS



Tweedie

Brown

Ling Electronics Names Tweedie Vice President

William A. Tweedie has been named vice president and general manager of the Ling Electronics, Anaheim, Calif., division of Ling-Temco Electronics, Inc.

Prior to joining Ling Electronics last Fall, Mr. Tweedie was with the Stanford Research Institute for several years in an executive capacity. He formerly was manager of Temco Aircraft Corporation's Garland, Texas, plant. Temco merged with Ling-Altec Electronics, Inc., in July, 1960, to form Ling-Temco.

John Thurston Elected Liquid Carbonic Head

John F. Thurston, vice president for special projects, General Dynamics Corporation, has been elected a senior vice president of the corporation and president of the Liquid Carbonic division, Chicago. In the latter capacity, he succeeds Rex L. Nicholson, who recently resigned.

Mr. Thurston joined General Dynamics in 1955 as manager of its Electro Dynamic division. He has been a vice president and member of the management board since 1957.

Aerotest Labs Promotes Brown to Chief Engineer

L. D. Brown has been appointed chief engineer of Aerotest Laboratories, Inc., Deer Park, N. Y. He will continue as chief engineer of the Long Island testing firm's Advanced Propulsion division.

Mr. Brown joined Aerotest in 1959. Earlier, he had been chief of test equipment at Fairchild Engine and an engineer with Pratt & Whitney.

* * * * * *

Clarke

McAdoo

Hajner

Townsend

JOHN H. CLARKE has been advanced from manager to vice president of the Systems division of COMPUDYNE CORPORATION, Hatboro, Pa., and **G. R. ARCHER** has joined the firm as general manager of the Process Control division. Clarke has held engineering positions in England with Metropolitan Vickers Electrical Company, Ltd., and L. Gardner and Sons, Ltd., and in Canada with Orenda Engines, Ltd. He joined CompuDyne in 1956. Archer was chief engineer of the Electronic Control section of the Budd Company and earlier was a research engineer at MIT.

* * *

T. H. TOWNSEND, JR. has been appointed manager for PURE CARBONIC COMPANY's central region with headquarters in Cleveland. He had been sales manager in New York City since 1956. His new territory consists of Ohio, Mich., eastern Ind., W. Va., Ky. and western Penna.

* * *

ROBERT D. HAJNER, formerly with Bendix Aviation Corp.'s Turbo Engineering Lab, and **G. DEAN McADOO,** former acoustics engineer with Boeing, have joined the Acoustics division of TENNEY ENGINEERING, INC., Union, N. J.

* * *

MARVIN R. STEIN is the new sales manager of the Force Transducer Sales division, HYDRO - PNEU - TRONICS, INC., Cleveland. He has been with The Clevite Corp., Curtiss-Wright Corp., Vickers, Inc. and The Reliance Electric and Engineering Co.

* * *

ROBERT BARROW, chief metallurgist, CONSOLIDATED VACUUM CORPORATION, Rochester, N. Y., has been elected chairman of the Rochester chapter of the American Society for Metals.

* * *

DONALD FOX, recently elected executive vice president of the IES, has been named regional sales manager of FENWAL INCORPORATED, with offices in Chicago. He will supervise sales offices in 14 midwestern states.

* * *

EDWARD D. BARRY has left the American Sterilizer Co. to become marketing services manager of the Instrument and

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* * *

RICHARD KEMLY has been named sales manager of SPACE-TRONICS, INC., Mineola, N. Y., a manufacturers' representative. He had been sales engineer for General Testing Labs, Standard Cabinet Corp. and U. S. Testing Labs.

* * *

LEO SIELSCH has been promoted to sales manager for TECHNOLOGY INSTRUMENT CORPORATION OF CALIFORNIA and **ED COOK** has joined the firm as test equipment engineer. Prior to joining TIC more than three years ago, Sielsch was general manager of Lido Transducers. Cook was previously with Canoga Electronics Corp.

* * *

RAYMOND G. YAEGER, head of the reliability and test department at Chrysler's Missile division, has joined GE's MSVD, Philadelphia, as program engineer responsible for planning, control and reporting on systems evaluation for the Advent satellite vehicle. A licensed P.E. in New York, he was formerly with the Naval Research Laboratory and with Bell Aircraft.

* * *

H. N. GILMORE, formerly of Powers Regulator Co., midwest sales manager for Robertshaw-Fulton's Aeronautical division and the Goodyear Aircraft environmental lab, has been appointed a field engineer of ENDEVCO CORPORATION. He will work out of the Gates Mills (Cleveland) office in Ohio.

Sielsch

Kemly

Gilmore

Anderson

AL ZIRKES, formerly health physicist at the Marquardt Corporation, has joined WYLE LABORATORIES, El Segundo, Calif., as staff engineer for safety, a new post embracing all Wyle divisions. He is a City College of New York graduate.

* * *

DONALD A. ANDERSON, district manager of Los Angeles facilities of THE RUCKER COMPANY, Oakland, Calif., for the past five years, has been named assistant to the vice president of the company, a new position. In other Rucker promotions, **THOMAS S. COZZENS** and **JAMES M. AYERS** have moved into sales manager posts for southern and northern California, respectively. Cozzens formerly headed northern California sales; Ayers was special accounts manager. Anderson, an M. E. graduate of Northwestern University, joined Rucker in 1953 as a sales engineer.

* * *

D. B. CLAPP, JR., formerly Pacific regional manager, has been named sales manager for the PURE CARBONIC COMPANY, New York, carbon dioxide supply division of Air Reduction Company, Inc. **A. L. RODEE,** Newark, N. J., field office manager, has been promoted to the Pacific regional spot. Clapp, a Princeton graduate, has been with Airco since 1946; Rodee with Pureco since 1929.

* * *

JOHN ALLEN, technical services manager of DAYSTROM'S Pacific and Wiancko divisions, has assumed responsibility for advertising for both divisions. He is located in Pasadena, Calif.

* * *

LASZLO J. BONIS has been promoted from technical director to executive vice president of ILIKON CORPORATION, Natick, Mass., and **IMRE FARKASS** has joined the firm as director of applied physics. Bonis, a former professor of metallurgy at the University of Technical Science of Budapest, was engaged in research and development at MIT before joining Ilikon in 1960. Farkass was previously associated with the Space Vacuum Lab at National Research Corp.

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Standard test chambers are expertly designed for accurate, reliable testing. Superior design and quality construction assure years of dependable service with a minimum of maintenance. Whatever the simulated condition desired, there is a Standard Cabinet designed specifically to do the job, guaranteed to give excellent performance.

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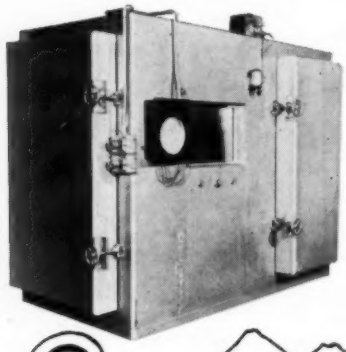

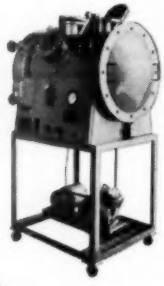

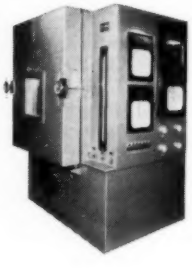

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MEMBER ENVIRONMENTAL EQUIPMENT INSTITUTE

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Hermann

Barnes

Tenney Names Hermann For New Coast Division

Tenney Engineering, Inc., Union, N. J., has organized a West Coast division at South Gate, Calif., with Fred Hermann, veteran Tenney special projects engineer, as manager.

The new division will manufacture environmental test equipment and handle field engineering "in the heart of our important West Coast market," Monroe Seligman, president of Tenney, said. It will be based at Harvick Manufacturing Corp., recently acquired by Tenney. Hermann has been named a vice president of Harvick, which designs and manufactures missile and airplane handling equipment.

Herman, a mechanical engineering graduate of Rutgers University, has been with Tenney since 1951. He is a member of the IES, ASHRAE and ASME.

Barnes Is Sales Chief For All of TIC of Acton

Malcolm H. Barnes has been appointed sales manager of all four divisions of Technology Instrument Corporation of Acton, located in Acton, Mass. He will be responsible for sales of instruments, mechanical products and environmental testing services.

For the past four years, Mr. Barnes has been a senior field engineer with Yewell Associates.

Kasabali

Baker

THOMAS N. KASABALI, formerly director of marketing for Idaho Maryland Industries, Inc., has been appointed general manager of UNIVERSAL TESTING LABORATORIES, Glendale, Calif., an IMI division.

* * *

JOHN R. BAKER has been named to the newly-created position of director of planning, for MB ELECTRONICS, New Haven. He was previously manager of countermeasure products sales in General Electric's Light Military Electronics department.

9639

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Even in the penguin's native habitat of Antarctica, the temperature rarely drops below −109.3°F. But you can achieve that frigid mark quickly and economically with Mathieson carbon dioxide in your environmental test chamber. With carbon dioxide, you can cold test well below the limits of government requirements.

The Olin Mathieson network of warehouses assures round-the-clock deliveries of carbon dioxide by truck or rail. Small user or large . . . cylinder, dry ice, or bulk liquid CO_2 . . . rely on Olin Mathieson for speedy deliveries. Write us for the booklet giving data on uses, storage and technical information. **Olin Mathieson, Baltimore 3, Maryland.**

CHEMICALS DIVISION Olin

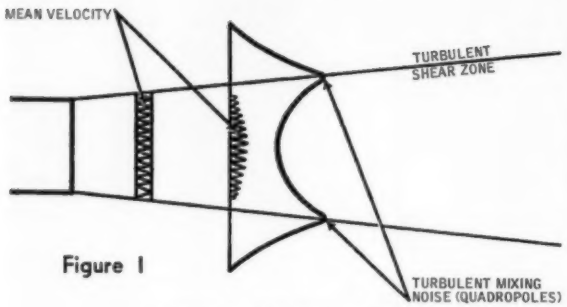


Figure 1

Octave Band Peak Distribution

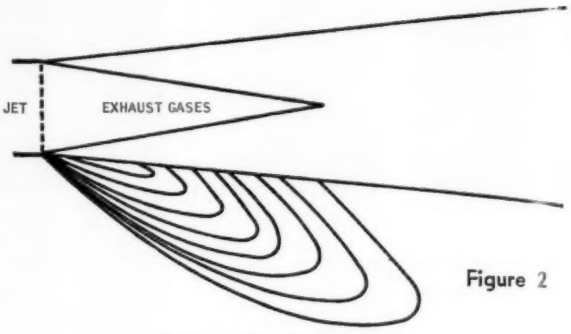


Figure 2

Exhaust noise of a jet engine

Predicting Flight Vehicle Noise

by William G. Dunn

Manager, Acoustics Division
Tenney Engineering, Inc.

The acoustic art is rapidly becoming a science, and predicted data is being accepted with increasing confidence. The acoustics engineer should continue to measure his environment, however, to substantiate and refine theory. Therefore, the need grows for variable equipment and accurate measuring devices.

CONSIDERATION OF A FLIGHT VEHICLE as a possible weapon system calls for four logical steps on the part of acoustics personnel:

- Predict the external acoustic environment in the near and far fields and in flight. (Near and far field predictions are a function of the type of power plant, whereas in-flight predictions are a function of the vehicle's motion, boundary layer and atmosphere turbulence—all limited to the vehicle's flight configuration.)
- Determine the noise reduction capabilities of the structure and the room characteristics of the vehicle's compartments. (Stiffness and surface density, as well as room reverberation and absorption, control noise reduction.)
- Analyze interior noise generators and ascertain their contribution to interior compartment noise levels. (At the same time investigate the possibility of eliminating undesirable noise levels with noise reduction devices.)
- Set up valid tests to qualify the vehicle, based on all available exterior and interior acoustic environment predictions.

Prediction of External Environment

Noise affecting a flight vehicle stems from the power plant, aerodynamic sources, such as boundary layer and turbulence, and internal components, such as defrosting and air conditioning systems. Fig. 1 illustrates types and sources of jet noise.

Each noise source requires a separate set of formulas and/or curves to evaluate and predict the acoustic environment. That due to the power plant, whether jet or rocket, can be predicted for ground runup or takeoff by:

1. Calculating the power level, locating the point in space, converting to sound pressure level and, by using theoretical formulas, determining the frequency spectrum and spatial distribution of the engine noise in the near and far fields. Fig. 2 is a graphic example of maximum lobes per octave band.
2. Ratio power plant operating parameters to a known power plant to compute a sound pressure level dif-

"Post Scripts" of the last issue of EQ contained some interesting observations by Bill Dunn on the state of the art of acoustic simulation. They prompted a request for fuller treatment of the subject, with this article the result. Bill's acoustics experience goes back many years, and he has variously specialized in research, design and experimental application of acoustics in the areas of acoustic models, noise reduction, simulation and prediction. He recently joined Tenney Engineering, Inc., as manager of its new acoustics division. Before that he was with North American Aviation, Columbus, as lead engineer of the dynamics laboratory's acoustic test section, and before that he was a dynamics engineer at Convair-Fort Worth. Bill attended Boston and Texas Christian Universities. He has published a number of technical papers on acoustics and has taught it at Ohio State University and other places.

Dunn

ference, and use free space contours of known power plant.

3. Build a scale model flight vehicle and scale model power plant, and with valid model parameters scale data to full scale. Fig. 3 shows contour lines on a vehicle wing which may have been determined from model data.
4. If the power plant is available, measure free space acoustic sound pressure levels, develop contours and apply them to the vehicle after surface and ground reflection effects are considered.

Measurement Important

Regardless of the method, near and far field measurements shall be made upon an early test vehicle to establish final contours peculiar to it.

In-flight predictions dependent on effects of motion, boundary layer and atmospheric turbulence can be made by theoretical calculations and assumptions based on correction angles and amplitudes with respect to ground runup sound pressure levels; measurements on a comparable vehicle and extrapolation to design vehicle within valid limits, and measurements in a wind tunnel, with data analyzed to conform with design vehicle configuration and flight parameters.

When a high intensity noise field impinges upon the external surface of a flight vehicle, it is reasonably valid to assume that the sound pressure level in the interior will increase according to the noise reduction capabilities of the structure. Fig. 4 shows the noise reduction calculated for a typical flight vehicle structure.

To ascertain noise reduction of the vehicle's compartments, one of four approaches may be used:

1. Calculate the transmission loss of the exterior shell and calculate the room characteristics of each compartment. By combining these two factors, noise reduction for each compartment is theoretically established.
2. Experimentally measure transmission loss and absorption coefficients of all materials peculiar to each compartment, using reverberation room and anechoic chamber techniques. Combine results into theoretical mass law formulas and solve for noise reduction.
3. Build a structurally similar mockup and measure noise reduction.
4. Measure noise reduction on an early test vehicle.

Sonic Fatigue

Although sonic fatigue life cannot be predicted with a great deal of accuracy, experience has shown some types of construction to be subject to this type of failure. Therefore, while a structure is undergoing rigorous examination for noise reduction capabilities, it is a good idea to be alert to sonic fatigue problem areas at the same time.

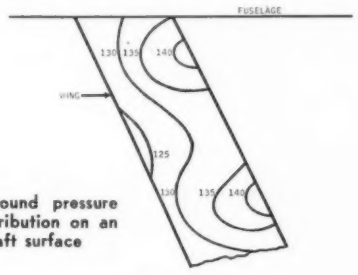
The problem areas will, in most instances, be in areas of high external sound pressure levels. Areas most susceptible to sonic fatigue include thin-gauge panels of large area and small aspect ratio, large panels with thin-gauge stiffeners and loaded clamps and brackets made of thin-gauge material.

Undoubtedly, some of these have been tested or have been considered for testing. Thus, a continuous file of tests, fixes, and failures should be maintained. Those parts still portraying doubtful and undesirable features should be sonic tested, either by a siren or in the actual noise environment.

Tests conducted with a siren are of a qualitative nature, consequently only comparison of design can be made. To obtain an absolute measure of the life, the structure must be tested in the actual noise environment, using a jet, rocket engine or random siren. For this reason, the engine must be used to identify problem areas and proof test the final structure.

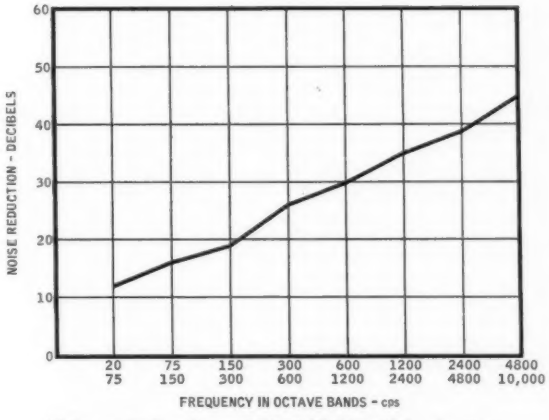
Internal Noise Devices

Such internal devices as auxiliary power systems can generate high noise levels inside a flight vehicle. Whether or not these devices are noise generators can be determined by theoretical calculations, if the system lends itself to them, by mounting the noise generating system in an anechoic chamber and measuring its output in sound pressure level, by mounting the noise generating system in a semi-anechoic and/or reverberant chamber similar to vehicle compartment and measuring sound pressure level increases due to room characteristics, and



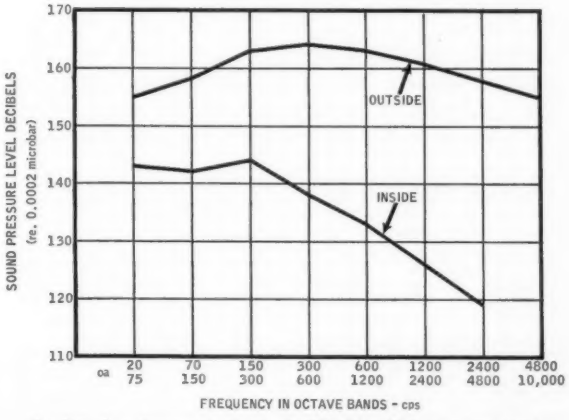
Typical sound pressure level distribution on an aircraft surface

Figure 3



Noise reduction for a typical flight vehicle structure

Figure 4

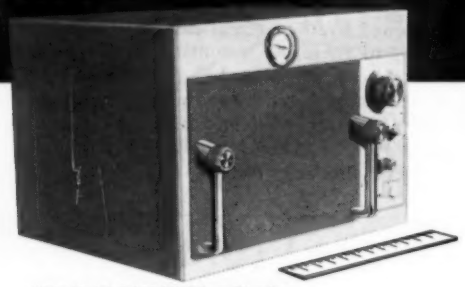


Predicted environment of a typical flight vehicle compartment

Figure 5

NEW! WYLE Miniature Temperature Chamber

For Small Parts and Black Boxes



Wyle Model C-106 Miniature Chamber

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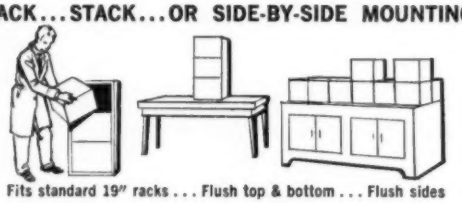
CLOSER TEMPERATURE CONTROL • COOLER OUTSIDE SKIN • BETTER OPERATING ECONOMY • GREATER FLEXIBILITY • FASTER HEATING & COOLING RATES

Revolutionary NEW "Sensor" The new Wyle liquid CO_2-cooled Model C-106 Miniature Temperature Chamber is the first to use a revolutionary new type electronic resistance bulb controller that "anticipates" temperature changes and thus effects minimum variation over the full range.

Extra thick layers of new, improved insulation retard flow of heat to outside skin . . . skin stays cooler. Interchangeable plug-in doors, with various provisions for specimen mounting, instrumentation, specimen operation, and observation, assure minimum downtime. All features lead to greater economy of operation.

RACK...STACK...OR SIDE-BY-SIDE MOUNTING



Fits standard 19" racks . . . Flush top & bottom . . . Flush sides

640 Cu. In. Capacity • −100°F to +500°F Range • 8" x 8" x 10" Test Volume Dimensions • Weight . . . Approx. 55 Lbs. • Heating & Cooling Rates . . . Up to 100°F per Minute

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by measuring sound pressure levels in early test vehicle compartments.

The prediction of the internal environment of a flight vehicle compartment and/or compartments is a straightforward procedure at this stage of the analysis. By reducing external sound pressure level by the amount of noise reduction calculated, internal sound pressure level is obtained. If an internal noise generating device is present, this added to the externally transmitted noise gives the operational compartment sound pressure level. Fig. 5 shows a predicted external environment reduced by the amount of noise reduction and an internal environment predicted for a typical flight vehicle compartment.

Evaluating Theoretical Predictions

Utilizing predicted external and internal sound pressure levels to acoustically qualify a flight vehicle requires that the environmental engineer envision the noise problem in parts. These parts are mission performance, personnel safety, and community reaction.

Foremost in qualifying a flight vehicle is mission performance. To an acoustical engineer this means:

- Sonic testing of structural components which are or have been known to be susceptible to excessive noise levels.
- Acoustical qualification of electrical, electronic and/or mechanical systems which are subjected to high internal noise levels.
- Noise reduction devices and/or mufflers for internal noise generating systems.
- Acoustical treatment of crew compartments within military specifications.
- In-flight noise suppression.

In addition to these items which can directly influence the success or failure of a mission, the acoustical engineer is confronted with the additional hazards of support personnel safety and community reaction. These require construction and use of runup pens, hushhouses, exhaust noise suppressors and/or intake noise suppressors; determining and enforcing safety zones for support personnel; evaluation of ear muffs and/or plugs; noise reduction devices and/or mufflers for ground support equipment, and indoctrination of the community to accept the noise and help them to understand its whys and wherefores.

State of the Art Advances

The state of the acoustical art in aeronautical engineering advances with each passing day. Like most other environmental problems, more theoretical approaches are being devised for preliminary analyses of the phenomenon called "flight vehicle noise." The art is trying to become a science, and in the process flight vehicle managers are coming to accept predicted data as fairly well representing the actual environment.

Due to the rapid strides being made, it is now possible to predict and foresee many acoustic problems heretofore only guessed at. Factual planning of expenditures, personnel, time and equipment can be made with a high degree of accuracy.

Hand in hand with the prediction methods is the need for accurate measuring devices and personnel. Equipment must be variable, to the extent of providing valid data over large frequency and pressure ranges, if it is to satisfy the needs of the acoustic engineer.

However, it still behooves the acoustical engineer to measure his environment to substantiate most predictions and to assist in the challenge of refining practical theory.

NEW PRODUCTS...

A READER SERVICE CARD requiring no postage is bound into this issue of ENVIRONMENTAL QUARTERLY for the convenience of readers desiring additional information on advertisements, new products, new literature (Page 43) and other announcements. Reader Service Card numbers and letters are keyed in the text as "EQ RSC."

SPOTLIGHT ON:

Giant Shaker

A 5,000-pound force electrodynamic "piggyback" shaker by **Ling Electronics** division of **Ling-Temco Electronics, Inc.**, is the latest king-size entry in the field of environmental vibration testing. Although created specifically for combined environments, the new unit features design simplicity (it can be disassembled and reassembled in less than two hours) and built-in capabilities that make it a practical laboratory unit even if combination tests are not immediately under consideration.

Designated **Model 300**, the shaker delivers 5,000 pounds (vector) force for sine wave testing and 12,000 pounds (vector) wide band random. It is designed to operate continuously at 1" peak to peak with no velocity limit. The armature weighs only 49½ pounds.

Ling's Model 300
Liquid Cooled

• Loop-Type Flexures

The Model 300 incorporates Ling's loop-type flexure systems, which provide both superior lateral stability and the ability to carry heavy loads when operating in the horizontal direction. The high lateral restraint permits use of the shaker with high rotational or lateral dynamic loads without the armature coil moving sufficiently to use up the clearance to the gap (electrical ground).

A failure in a package under test can cause large unbalanced loads to be transmitted to the armature. Ability to withstand such loads without concurrent armature failure is a very important advantage claimed for the loop-type flexure.

Stainless steel sheeting completely encloses the armature coil, making it practically indestructible. That the coil is lighter than any in this force range is attributed to internal, direct water cooling.

Cooling is an important aspect of Model 300's design. A closed loop system circulates distilled water through the shaker at 5 gpm. Heat is exchanged via the water to a water heat exchange. (User-supplied raw water circulates at 7½ gpm. 60° F, 20 psi is required.) Cooling paths are hermetically sealed so that the cooling medium is never exposed to the chamber pumping system.

Water cooling eliminates noise characteristic of air cooled shakers and permits audio inspection of package resonances.

The directly cooled armature field and compensating coils allow operation either in chamber or piggyback from —100° to +350° F, without altitude or humidity limits. With special provision, piggyback testing to +700° F is possible.

• Temp-Alt Tests

The shaker's standard armature includes thermal insulation necessary for testing with temperature extremes at altitude, and the shaker top is completely sealed from the interior. The first armature resonance is above 3,000 cps.

A unidirectional shaker isolation system is built into the Model 300 at the trunnion. The all-metal support construction is impervious to aging, environmental conditions and wear.

A unique feature, important to those who use auxiliary tables for vibration testing, is the single-axis compliance. This is always parallel to the axis of excitation and extremely stiff, both laterally and torsionally, about the trunnion center line. This gives positive angular positioning of the shaker body while retaining full isolation.

In addition, the trunnion rotation locks are positive, quick-action lever operated and they are independent of both trunnion bearings and isolators.

• Other Design Features

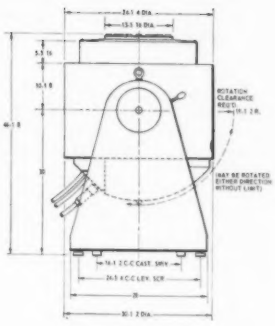
An important feature of the Model 300 is its simplicity of design. Field coils, for example, are completely encapsulated. They are wound from copper tubing and cooled internally so that virtually all of the heat generated is taken out in the cooling water and exchanged via a closed loop water-to-water cooling system.

The entire inside of the shaker is sealed, so that it may be separately evacuated with a small roughing pump. This makes it possible to attain very high altitudes at the test package.

Ling's new velocity signal generator is included to monitor displacement. It eliminates coil failure problems typical of old signal generator coils and provides an accurate linear velocity signal independent of table load.

Other specifications of the Model 300:

Max. acceleration: 100 g.
Max. load for 10 g vector: 450 lbs.
Max. load for 20 g vector: 200 lbs.
Flexure stiffness: 1,000 lbs. per in.



Dimensional View
(sizes in inches)

Lateral stiffness: 14,000 lbs. per in.
Freq. range: 5 to 3,000 cps.
Table diameter: 13¼ in.
Length: 43½ in.
Width: 30½ in.
Height: 46⅛ in.
Weight: 4,000 lbs.
Mobility: Casters
Heat exchanger cabinet: 57" x 36" x 34" high.
Standard cable and hose: 20 ft. shaker to heat exchanger.
Standard cable: 30 ft. heat exchanger to amplifier.
Personnel protection: Field discharge rectifier.
Field power: 25 kw.
Stray field, 3 in. above table: Less than 3 gauss.
Field coil configuration: Center gap, double field construction.

(For more information on Ling Electronics' Model 300, water-cooled, 5,000-pound force electrodynamic shaker circle EQ RSC "A.")

* * *

SPOTLIGHT ON:

Transducers

From **Endevco Corporation** has come a new series of shock and vibration transducers for environmental testing. Here are examples of increased versatility in design and production of piezoelectric accelerometers:

• Low Noise Tests

Model 2217 provides a high nominal sensitivity of 72 pk-mv/pk-g and a wide freq. range (resonance frequency is approximately 30kc). Hermetic seal extends usefulness. Weight is only 1.1 oz.

Typical application is the Navy's test program on rotating equipment for submarines. Little affected by magnetic fields of motors, the accelerometer is suited to a wide variety of applications. When used in the **Endevco Model 2870**

Endevco Model 2217

Environmental Want Ads

Rates: $5 (minimum) for three lines, $2 per line additional. **"Situation Wanted" ads free** (except for reply box number) to those who can reasonably expect to find employment in the environmental industry, but prescribed form (given below) must be followed. First three lines free to those who write own "Situation Wanted" ads. **Reply code number $2,** but no charge for handling replies. **Payment in full with copy, except from recognized agencies.**

Deadline for Oct., 1961, issue is **Sept. 10, 1961.** Send order, copy, payment and all inquiries to Environmental Want Ads, Environmental Quarterly, 252-46 Leeds Rd., Little Neck 62, N. Y. **For classified display information, write for rate card.**

For free "Situation Wanted" ad give only following information in this order: Job title (two permitted), age, (if desired), degrees, recent experience, salary desired, where you prefer to work and name and address. (Last two will be withheld if reply code is used.)

SALES REPS WANTED

WEST COAST AND CHICAGO representatives who already handle environmental equipment wanted to sell Solar Radiation Simulators manufactured by New York firm. Mail outline of your organization to Genarco Inc., 97-04 Sutphin Blvd., Jamaica 35, N. Y.

USED EQUIPMENT

BOWSER ENVIRONMENTAL Test Chamber 36 x 25 x 36. Temp range—100° to +180° F. Vacuum to 80,000 ft. Complete with Foxboro programmer. Used, good condition. Best offer takes. Additional information on request. Auto-Test, Inc., 600 South Michigan Ave., Chicago 5, Ill.

vibration measuring system, measurement of .00045 rms G is obtainable.

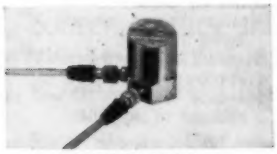
• **Very High Sensitivity**

High output of 250 pk-mv/pk-g in the new **Model 2219** offers new possibilities for measuring low vibration levels. Combining the Model 2219 with the **Endevco Model 2607M4** amplifier and **Model 2624** power supply provides signal to noise ratio of 10 db for .0002 peak G (one-half microinch displacement at 60 cps.)

Resonance frequency of this new transducer is 12 kc nominal; temperature response with 100 pf external capacity is ±8% nominal deviation for +32° to +230°F; unit weighs 2.75 oz., is made of stainless steel and is .917" x .812" high with 15/16" hex base.

• **In Flight Calibration**

Model 2242M5 high temperature accelerometer provides for in-place calibration of the tele-



Model 2242M5

metry system. Precision resistor is sealed in the base of the accelerometer so that a known current will simulate a specified G level. A charge is developed at the accelerometer proportional to its sensitivity, so that a complete system checkout can be accomplished with the equipment in place.

All-welded hermetic construction incorporating a special thermal shield permits operation for four minutes with nearby radiant surface temperatures 750°F.

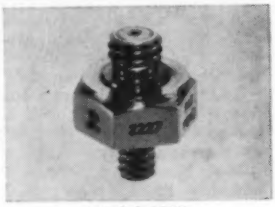
Use in the **Endevco 2630** series system-packages illustrates an important design feature: Systems can be selected, calibrated and stocked without knowing the exact length of cable to be run in the final test, and damaged cables can be replaced without affecting the system calibration. Reason: The 2630 series uses a unique "charge" amplifier; the "charge" generated by the transducer is independent of cable capacitance.

• **High Level Shock Testing**

Model 2225 accurately measures shock and impact transients because of high resonance frequency of 80 kc nominal. Dynamic range of this new transducer is a maximum sinusoidal 10,000 G and a maximum shock of 20,000 G with a 75 usec half sine pulse. The high G range and the low sensitivity make it ideal for high level shock testing. Nominal sensitivity is .6 pk-mv/pk-g with 300 picofarad external capacity. Model 2225 weighs only .46 ounces (13 grams) and is .52" high with a 9/16" hex base.

• **Microminiature Accelerometer**

Model 2227 microminiature accelerometer weighs only 3.1 grams. It is 3.8" hex and ½" high and includes an integral



Model 2227

6-32 stud. The design provides mechanical isolation from noise-producing cable stress. Voltage sensitivity with 180 pf external capacity is 5 pk-mv/pk-g nominal; resonance frequency is 30 kcps nominal; cross-axis sensitivity is 5% max.; temp. range is —65° to +350°F with 15% or less nominal sensitivity deviation throughout the range.

• **2200° F Accelerometer**

Model 2206 is a small, high temp shock and vibration transducer, especially suited for dynamic measurement in rocket motors, combustion chambers, turbines, etc. Liquid cooled, it can operate continuously on surfaces with temperatures up to 2200°F, maintaining performance characteristics comparable to those of lower temperature Endevco models.

(For more information on Endevco shock and vibration transducers circle EQ RSC "H."

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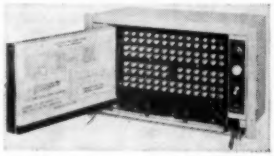
UNIVERSAL THERMOCOUPLE HEAT SINK

for quick reference junction compensation by **Research, Incorporated,** provides 51



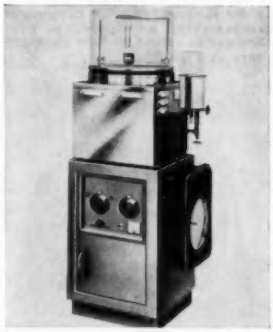
pairs of sockets to accommodate all types of thermocouple wire interchangeably. An additional pair of sockets permits monitoring of copper heat sink, controlled at 150°F. Each thermocouple wire is wedged into separate heat-sink socket by means of tapered plastic sleeve.

For More Information Circle EQ RSC #1

* * *

RELATIVE HUMIDITY CHAMBER

Model VP-206A, by **Blue M Electric Company,** designed to meet humidity cycle spec of MIL-202B, Methods 103A (Procedure 2) and 106A (Steps 1-6), permits automatic cycling between 25° and 65°C, ±1°. Humidity is constant within ±1% through complete cycle. Control system does not involve



contacts or arcing devices. Both wet and dry-bulb controls are guaranteed for straight-line performance. Chamber is 16" diam x 14" high. Features include stainless steel base, copper cooling coil, adjustable airflow and 24-hr. timer.

For More Information Circle EQ RSC #2

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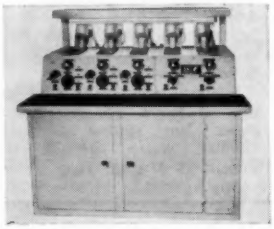
TEMPERATURE CALIBRATION CABINET

by **American Research Corporation** contains five welded stainless steel baths equipped with individual mixers. Lowest



temp range is —30° to +40°F, highest is +230° to +300°F. Ranges can be extended to —100°F. Automatic control of ±.1°F is claimed. Unit is self-contained. Each bath is 4" x 8" x 6" high.

For More Information Circle EQ RSC #3

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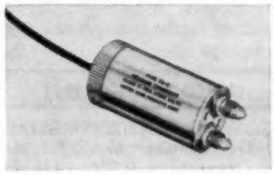
ALL-STAINLESS PRESSURE TRANSDUCER

Type 78-C, by **United Aero Products Corp.,** is designed for precise pressure measurement in limited space. High continuous output is provided with low ac-



celeration response. Ni-Span C pressure element is linked inductively to differential transformer of high sensitivity. OD is 1¼". Pressure ranges are available from 0-5 to 0-350psi, gauge, absolute or differenti . Temp range: —115° to +50 F.

For More Information Circle EQ RSC #4

* * *

LIGHTWEIGHT SHAKE TABLES

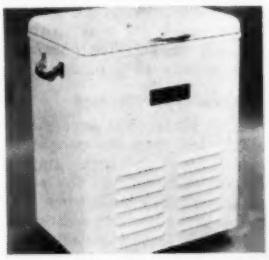
Series RH-5220, by **L.A.B. C rporation,** produce 3.2G horizontal vibration for electronic equipment testing. Units are available with one or two tables in a wide variety of sizes. Tables are supported by spring and cable suspensions which isolate vibrations from floor. Generators are constant-displacement type. Standard freq is 25 cps, ±5 cps. Max capacity per table: 500 lbs. **Series RV-5340** produce 3.6G vertical vibration. Prices of both series: $4,000-$7,000, depending on size and equipment.

For More Information Circle EQ RSC #5

* * *

MINIATURE TEST CHAMBER

Penguin/5, by **Cincinnati Sub-Zero Products,** is designed for continuous, low-cost operation



in transistor testing, miniature bearing manufacture, pharmaceutical storage and other uses. Standard low temp range is —10°F to —60°F; high range to +500°F is available. Mechanically refrigerated chamber is 15" x 9" x 8" high. Caster-mounted unit occupies under 2½ sq ft of floor space.

For More Information Circle EQ RSC #6

* * *

SIREN-TYPE NOISE GENERATORS

"Acousti-Dyne" Series, by **American Measurement & Control, Inc.,** subsidiary of **CompuDyne Corporation,** are designed for

high-intensity sound for research and testing. **Model 825** can generate over 164 db sound pressure level in 1 sq ft test section, **Model 830,** 168 db and **Model 835,** 174 db. Sirens are 6", 12" and 24", respectively. Freq range: 50 to 10,000 cps. Integral units contain siren, controls, hy-

draulic power supply, air compressor, aftercooler, test section and associated equipment. Multiple units can be operated simultaneously.

For More Information
Circle EQ RSC #7

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WIDE RANGE REPEAT CYCLE TIMER

by **Technitron Co.**, is intended for environmental, life-cycle and electro-mechanical testing and

photographic applications. Has independent time-rate controls for "on" and "off" cycle. Lights indicate relay position, and a switch provides "hold" in either position. Relay has 15-amp D.P.D.T. contacts with 1500 VAC insulation. Time rates are approx 3 min. (max) to 30 millisec (min) with 1% repeatability on standard model.

For More Information
Circle EQ RSC #8

HIGH PRECISION G-ACCELERATOR

Model B931, by **Genisco, Inc.**, is electronically controlled centrifuge with outboard table for

research, development and testing applications. Adjustable, discrete operating channels up to 30G's are provided. Operating modes include fixed azimuth orientation. Rotating arm assembly and outboard table are individually motor-driven with allowable drift from angular velocity of .001%. Nominal radius of arm: 24", of outboard table: 8"; max loading of fixed mounting platform: 25 lbs, of table: 10 lbs. Similar model available without variable-speed outboard table.

For More Information
Circle EQ RSC #9

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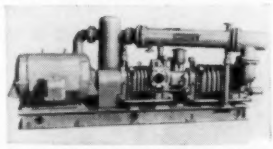
2-STAGE, SCREW-TYPE AIR COMPRESSORS



Spiraxial Series C-100, by **Roots-Connersville Blower** division of Dresser Industries, Inc., delivers high-purity air at 100 psig for a variety of applications. Drive is standard 3600-rpm motor or turbine. Features include shell-and-tube intercooler, diaphragm-operated relief valve, discharge snubber and integral oiling system. Auxiliary 2nd-stage oil pump is provided for start-up. In seven sizes from 900 cfm to 3,000 cfm. Smallest unit is 7 x 3½' wide, excluding drive; weight: 4,000 lbs.

For More Information
Circle EQ RSC #10

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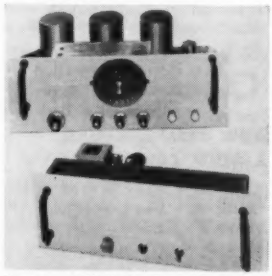
THREE-PHASE WIDE-BAND GENERATOR



Model AG3-030, by **Communication Measurements Laboratory, Inc.**, provides 30 volt-amps output over freq range of 50 to 6000 cps. Voltage output at full power is 90 to 130v with claimed regulation of .5% from no load to full load. Voltage stability is said to be ±.5%, freq stability ±.25%, and distortion less than 1%. Use in missile system checkouts is indicated. Unit consists of power supply and amplifier chassis, each requiring 7" of panel height in standard 19" rack. Weight is 105 lbs. Price is $1,045.

For More Information
Circle EQ RSC #11

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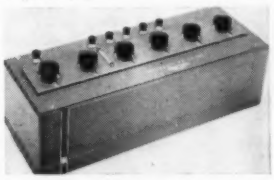
PRECISION SIX-DIAL UNIVERSAL RATIO SET

Model 4393, by **Leeds & Northrup Co.**, permits accurate cali-



bration of DC potentiometers and Wheatstone bridges. Total resistance is 2111.11 ohms. Accuracy for dial changes of 100 ohms or over is .002% at 25°C; for changes under 100 ohms: within two steps on .001 dial. Case is gray vinyl-covered metal.

For More Information
Circle EQ RSC #12

* * *

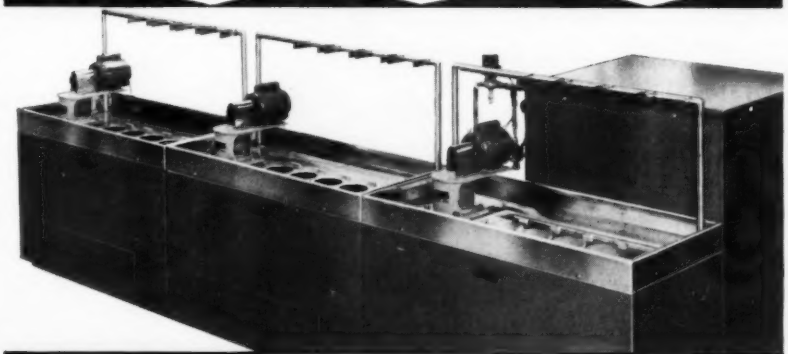
VACUUM COATING SYSTEM

Model 3164, by **NRC Equipment Corporation**, forms thin metallic films with vacuum produced by 4" diffusion pump rated at 750

PRECISION 3-ZONE MASS PRODUCTION LIQUID TEMPERATURE CALIBRATION BATHS +150°C. to −85°C.

For precision temperature calibration on a mass production basis. Three separate agitated liquid baths. Fast recovery after loading. Complete recovery in 10 minutes with 1,000 BTU thermal load. Stainless steel cabinet tops contoured at rear to drain off oil drippings from fixtures hung on drying racks. Open rolled edges on top wall prevent liquids from creeping beyond top. Temperature variation in each bath less than 1°C. ± .1°C. point control (repeatability, speed of response, and on-off differential). Each chamber, 5 cu. ft.

TEMP. RANGE	HOT +150° to +50°C.	MEDIUM +50° to +20°C.	COLD −20° to −85°C.
CAPACITY	6,000 BTU/hr.	1,000 BTU/hr.	6,000 BTU/hr.



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Refrigeration experts since 1934. Environmental testing equipment for every requirement, standard or custom models. Write for our advice. No obligation.

BENCH-TYPE 3-ZONE SMALL BATHS

Each bath 4" dia. x 4" deep, same temperature range as large unit. Hot, +150° to +50°C.; medium, +50° to +20°C.; cold, −20° to −85°C. ± 1°C. control.

liters / sec. Optional bell-jar chambers are 14", 18" or 24". A larger system, **Model 3166**, employs 6" pump with either 18" or 24" chamber. Hand or remote-controlled air-operated **valves are available.**

For More Information Circle EQ RSC #13

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IMPEDANCE TEST DEVICE

Model 2110, by Endevco Corporation, incorporates three force transducers and three accelerometers in the same plane for accurate mechanical impedance measurement. Use is indicated

in analysis and testing of structural vibrations in a variety of applications. Nominal force sensitivity of 7 pk-mv/pk-lb and nominal acceleration sensitivity of 80 pk-mv/pk-g are claimed. Freq response (± 5%) is 2 to 4,000 cps with 1,000 megohm load and 5 to 4,000 cps with 100 megohm load. Entire top and bottom surfaces are load bearing members, resulting in a gage with stiffness of 2×10^7 lb/in (min). Unit is cylindrical, 1.935" diam x .973" high, with center mounting-hole. Weight: .53 lb. Price: $750.

For More Information Circle EQ RSC #14

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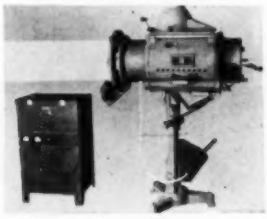
CARBON LAMP SOLAR RADIATION SIMULATOR

by **Genarco, Inc.,** produces a beam of radiation said to be of the same intensity, spectrum



distribution and divergence as the sun in the outer atmosphere. Illustrated is **Model ME4,** which produces a beam 12" diam. Source of the radiation is a high intensity carbon lamp. Simulator is delivered complete with power supply and quartz optical system. Other models made to order for particular requirements.

For More Information Circle EQ RSC #15

CURVE FOLLOWER

Data-Trak Function Generator by **Research, Inc.,** converts man-

ual set-point to automatic program control. Easily connected to present circuits. Four 3-gang pots may be driven by same follower mechanism to provide up to 12 separate synchronized control signals. Nineteen-inch dust-tight case fits standard rack. Standard strip-chart recorder paper may be used.

For More Information Circle EQ RSC #16

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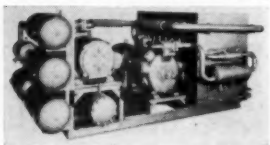
LOW TEMPERATURE LIQUID COOLER

Model W-120, by **Webber Manufacturing Co.,** designed for —120°F (±.2°) with cooling



fluids such as trichloroethylene, acetone and methylene chloride. Capacity is 120,000 BTU/hour at —100°F. Self-contained unit is 50" high and occupies 10 sq ft of floor space.

For More Information Circle EQ RSC #17

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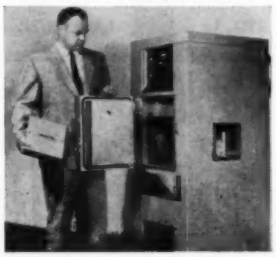
FULL-OPENING TEST CHAMBER

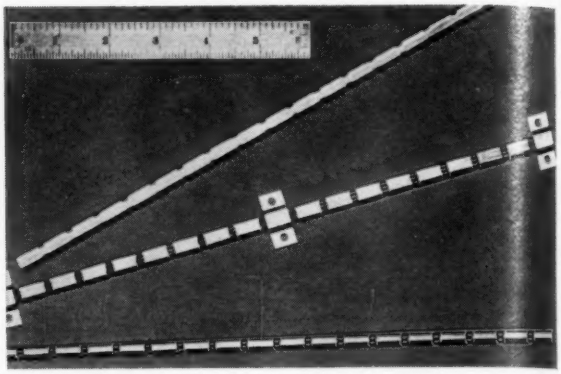
Model TEC-6R, by **Auto-Control Laboratories, Inc.,** provides me-



chanical cooling from ambient to —100°F in 30 min and electrical heating from ambient to +400°F in 20 min. Indicating thermostat controls temp to ±2°F. Circulating fan holds gradient to ±2°F. Refrigeration system is air-cooled. Stainless steel chamber is 12 x 12 x 19" deep with usable volume of 1.5 cu ft. A bench-top unit, **Model TEC-6V,** has liquid or solid CO_2 cooling and —100°F to +500°F range. Both models are portable. Similar units available from 2.5 to 10 cf.

For More Information Circle EQ RSC #18

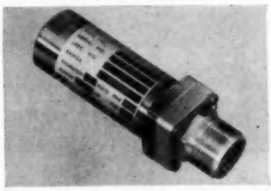
'Strip-Damper' Minimizes Vibration



An inexpensive, easy to apply vibration damping device, the **Strip-Damper,** by **Barry Controls** division of Barry Wright Corporation, minimizes vibration response of air frame components, electronic chassis and shock and vibration test fixtures. Designed to complement Barry Controls' **RIGIDAMP** structural damping technique, it is an add-on device available in 11¾" strips ($4 each) weighing less than 1½ oz., which may be cut to shorter lengths. Strip-Dampers dissipate the mechanical energy of vibration through viscoelastic shear damping. They are attached with special clips or epoxy glues. Tests have shown Strip-Damper will reduce vibration response up to 85% and extend resonant fatigue life from a few minutes to several hours. It can be used under operational temps of —80° to +350° F and is resistant to moisture, fungus, oils, solvents, weathering, ozone, aging and material fatigue. **(For more information circle EQ RSC "C.")**

PRESSURE TRANSDUCER

Type 4-350, by **Consolidated Electrodynamics Corporation,** is said to have over-pressure capa-



bility (up to 10,000 psi) of 10 times rated range, 50 mv sensitivity and linearity and hysteresis of ±.35%. Pressure ranges: 0-100 to 0-5,000 psi, absolute and gage. Operating temp: —320° F to +300° F. Designed to windstand 1000G shocks.

For More Information Circle EQ RSC #19

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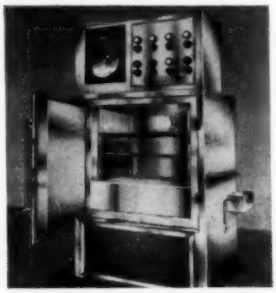
VERSATILE, UPRIGHT TEMP-HUM CHAMBER

by **Hudson Bay Co.,** division of **Labline, Inc.,** operates at 0° to



200°F ±2° and 20 to 95% rel hum ±5%. Applications include testing of chemicals, electronic components, plastics, packaging, coatings and paints. Immersion-type heater in open water-pan provides humidification. Dehumidification is obtained with direct-expansion coil. Unit also contains mechanical refrigerating system, motor-driven air circulator, wet and dry-bulb thermostats and gravity drain. Monel chamber is 19" x 19" x 15" deep; stainless steel exterior is 27" x 69" x 33" deep. Insulation: 4" of Fiberglas.

For More Information Circle EQ RSC #20

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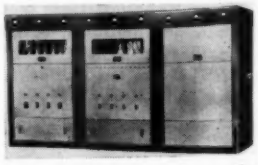
PULSE MODULATOR

Model PM-87, by **Ling Electronics Division, Ling-Temco Electronics, Inc.,** produces 64-mega-



watt peak power for testing super-power electronic equipment. Average power is 75 kw. Pulse range is continuously adjustable from 75 to 250 kv with a pulse current at 250 kv of 260 amps. Freq: 30 to 60 pulses per sec. Warm-up is automatic. Ignitron temp maintenance system requires ½ gpm of 15 psi water. Self-contained fans exhaust air at 2,800 cfm. Power required: 480 v, 3-phase and 120 v, 1-phase. Exterior is 54"

x 162" x 90" high, exclusive of transformer tank and klystron socket. Weight: 20,000 lbs.

For More Information
Circle EQ RSC #21

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PRECISION SERVO ACCELEROMETERS

Glennite Series LA, by Gulton Industries, Inc., a line of triaxial, biaxial, and unidirec-

tional units, provide measurements for guidance, installing precision equipment, calibration and other systems requiring secondary acceleration sensing capabilities in two or more planes simultaneously. Unidirectional unit is essentially non-sensitive to cross-axis acceleration and temp zero shift. Units have a current injection, self-checking feature. Basic price for unidirectional unit: $445. Delivery in 90 days.

For More Information
Circle EQ RSC #22

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PULSED X-RAY VIEWING SYSTEM

Model 5660, by Zenith Radio Research Corporation, permits taking motion pictures of high-speed objects in enclosures opaque to visible light. System

consists of X-ray console, which produces up to 30 pulses per sec, and image-intensifier console. Specimen is placed between consoles. Image, which appears on screen in intensifier console, is suitable for direct viewing, closed-circuit television or motion picture camera. Input power is 115v, 60 cps. High voltage in X-ray console is completely shielded. X-ray console is 26" x 22" x 47" high; weighs 600 lbs. Intensifier console is 21" x 22" x 47" high; weighs 100 lbs. Also available is **Multex System** equipment which generates up to 20 high-energy X-ray flashes in 10 millisec from a single source. Price of Model 5660: $54,500.

For More Information
Circle EQ RSC #23

DOUBLE INTEGRATING VIBRATION METER

by **Unholtz-Dickie Corporation** has three complete channels with meters, allowing simultaneous monitoring of displacement, velocity and acceleration from any piezoelectric accelerometer. Rack mounted, the instrument uses a common power supply. A dial automatically normalizes output when set to the input accelerometer's sensitivity. Price: $1,670. Delivery: 2 to 3 months.

For More Information
Circle EQ RSC #24

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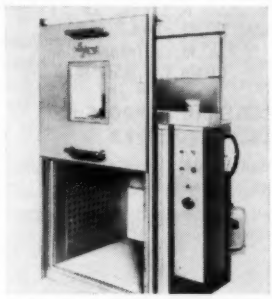
PASS-THROUGH TWO-DOOR OVEN

Model 1408-M, by Electric Hotpack Co., operates continuously at 600° F and accommodates electronic components, paints, metals, or chemicals. Blower



and adjustable ventilators are provided. Sliding lift doors and chamber are aluminum. Steel exterior has enamel finish. Standard controls include indicating thermostat, pilot light and 3-heat selector switch. Viewing windows are optional. Chamber dimensions: 32" x 25" x 30" high. Exterior dimensions: 53" x 38" x 64" high. Larger models are available.

For More Information
Circle EQ RSC #25

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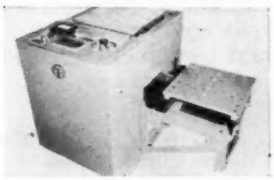
THREE-TABLE VIBRATION MACHINE

Type RVP-16-50, by L.A.B. Corporation, permits simultaneous, multiple object testing in quality control and research applications. Main, vertical direction table has 50-lb. load capacity,

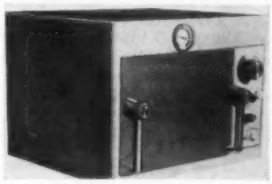


15G max acceleration rating and total excursions up to .1" max. Side tables for horizontal direction testing are available as separate items. Manual or automatic control permits 2 cps/sec sweep of 5 to 60 cps freq range. Specimen mounting surfaces are 16" square.

For More Information
Circle EQ RSC #26

LIQUID CO_2-COOLED TESTING CHAMBER

Model C-106, by Wyle Laboratories, Inc., provides fast heat-



ing and cooling rates in temp range of —100° to +500°F, ±.5°, for testing electronic, missile and aerospace components. Can be mounted in standard 19" rack. Internal volume: 640 cu. in., exterior 17¼" x 12¼" x 21" deep, excluding mounting flanges. Electronic controller with resistance bulb sensor keeps temp. variations to a minimum. Optional equipment: thermometer, CO_2 hose and fittings, door with shelves, ports, windows.

For More Information
Circle EQ RSC #27

* * *

REMOTE-LOCATION NOISE-FREE PROBE

Model 300, by United Aerotronics Corp., is designed for —200° to +500°F temp range. Signal loss per 100 ft: approx 2%. Probe is available in any length.

For More Information
Circle EQ RSC #28

DU-O-PANE®
Manufacturers of
WINDOWS FOR ENVIRONMENTAL TEST CHAMBERS
Specialists in
REBUILDING OF DEFECTIVE WINDOWS OF ALL MAKES
CONVERSION TO RANGE OF -180° to +1000°
OUR SATISFIED CUSTOMERS INCLUDE:

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BUtterfield 8-2600, Area Code, 212

IMPROVED VACUUM DIFFUSION PUMP

Model HS 4-750, by **NRC Equipment Corporation,** subsidiary of **National Research Corporation,**

has peak speed of 750 liters/sec between 1 x 10^{-3} and 3 x 10^{-5} mm Hg. Operating range extends from 450 microns to under 1 x 10^{-9} mm Hg. Forepressure tolerance at blank-off is 650 microns. Backstreaming is less than .02 mg/cm²/min. Unit height: 16". Projected floor space: 13" x 10". Weight: 28 lbs. Pump inlet is 5¼" and accommodates standard 4", 150-lb flange. Stainless steel and aluminum construction.

For More Information
Circle EQ RSC #29

ELECTRIC STEAM GENERATOR

by **Hot Shot Division, Automatic Steam Products Corp.,** provides humidified atmospheres for environmental testing. Pressure range: 0-100 psi. Operates on tap or distilled water. Available in a variety of models and sizes including 1/3 to 20 BHP.

For More Information
Circle EQ RSC #30

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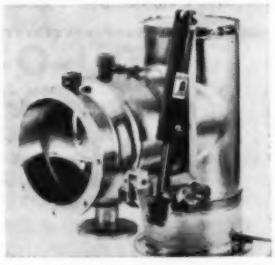
VACUUM MANIFOLD ASSEMBLY KIT

Vacukit, by **Delta Design, Inc.,** permits quick construction of custom high vacuum systems of predictable performance by coupling with metal diffusion



or mechanical pumps. Assembly is simplified, without need for machining or welding. Manifolding is stainless steel. Available for all popular 4 to 10-inch pumps.

For More Information
Circle EQ RSC #31

MODERATELY-PRICED TEMPERATURE CHAMBER

Econ-O-Line Mark II (Model ELH-0.5-LC), by **Associated Testing Laboratories, Inc.,** has

liquid-CO_2 cooling, resistance element heater, United Electric indicating controller, circulation fan with external blower motor and aluminum liner. Temp range: —100° to +350°F. Chamber is 11"x12"x5". Price: $285, FOB plant.

For More Information
Circle EQ RSC #32

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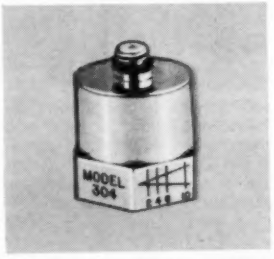
GENERAL PURPOSE ACCELEROMETER

Model 304, by **Columbia Research Laboratories,** is said to



have high sensitivity, stability and accuracy in severe acoustic-noise, temp, alt and hum environments. Nominal sensitivity: 50 mv/g. Flat freq response within ±5% from .09 cps to 10kc. Resonant freq: 55 kc. Acceleration range is .02 to 40,000G with max cross-sensitivity of 5%. Stainless steel hexagon case is 11/16 x .7" high. Weight: 28 gm. Price: $127.50 to $150, depending on quantity.

For More Information
Circle EQ RSC #33

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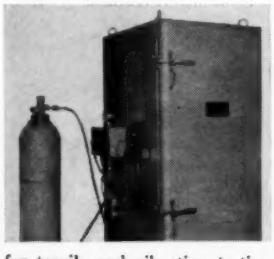
TEMP-HUMIDITY TEST CHAMBERS



for tensile and vibration testing by **Development Engineering Co., Inc.,** have —100° to +500° F temp range and are available with a variety of instruments and controls. Cooling with liquid CO_2. DEVELCO-PULSE control is featured.

For More Information
Circle EQ RSC #34

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MEASURING SYSTEM FOR SINUSOIDAL VIBRATION

VMS, by **Chadwick-Helmuth Co.,** permits continuous automatic recording by creating an exact slow-motion replica while accelerometer signal sweeps

from 10 cps to 10kc. Any slow motion from 1/3 to 3 cps can be used, and the record requires very little reduction. Said to be adapted easily to existing equipment, the unit is priced from about $4,500 (5 channels) to $6,000 (10 channels), with eight-week delivery.

For More Information
Circle EQ RSC #35

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TOP-OPENING COLD CABINET

Model PB65-B, by **A. M. Harris Industries, Inc.,** operates at

—70° F to —120° F. Condenser is air-cooled. Interior is 47" x 15" x 16" deep; exterior is 57" x 25" x 45" high. All-steel construction. Power input is 230v, 60 cycles, 1-phase.

For More Information
Circle EQ RSC #36

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COLD JACKET VACUUM FURNACE

by **F. J. Cooke, Inc.,** operates continuously at 2500°C (4500°F) and is available for temps from 1200°C. Internal heat is provided by six pairs of tungsten strips suspended by water-cooled low thermal feed-throughs. Entire assembly is in a water-cooled vacuum jacket. Hot zone is 3½" x 5" high.

For More Information
Circle EQ RSC #37

+500°F TO -100°F in SIX minutes

With NEW DELTA TEMPERATURE CHAMBER

MODEL 1060F

Rapid temperature cycling without sacrificing precise control (± ½ ° F) is achieved with the Delta 1060F temperature chamber.
This convenient bench model can make the complete cycle between —100° F and +500° F in less than twelve minutes.
An auxiliary timer Delta MR-1 is available for use in test work where automatic cycling is desired.
For further information on the 1060F and other Delta temperature chambers, contact your local Delta representative or write

DELTA DESIGN INC.

3163 Adams Ave.
San Diego 16, Calif.
ATwater 3-3193
TWX: SD 6488U
Cable: DELTA

LITERATURE FOR ENVIRONMENT...

Harris Manufacturing Co., Inc., Cambridge, Mass., offers data sheets and catalog folders on a number of unusual and special applications of its low-temperature environmental equipment at Electro-Switch Corporation, Raytheon and other installations. **(Circle EQ RSC #50.)**

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Enviratron Company, Van Nuys, Calif., has an illustrated brochure on custom-designed environmental test and ground support equipment for aircraft and missiles. **(Circle EQ RSC #51.)**

* * *

Tenney Engineering, Inc., Union, N. J., has prepared a four-page color bulletin on the Stentor series of wide-band noise generators. A complete acoustic test facility is outlined. **(Circle EQ RSC #52.)**

* * *

Murphy & Miller, Inc., Chicago, has compiled a notebook of catalogs on a wide range of environmental test chambers, cloud and pour cabinets and compressed air and gas dryers. The spiral bound notebook is printed in color. **(Circle EQ RSC #53.)**

* * *

Rototest Laboratories, Inc., Lynwood, Calif., discusses facilities for environmental testing and performance measurements in an illustrated, four-page brochure. Capabilities in vibration, high temp, vacuum and other areas are described. **(Circle EQ RSC #54.)**

Consolidated Vacuum Corporation, Rochester, N. Y., is offering a 30-page bulletin No. 10-1 describing a comprehensive line of high-vacuum valves, baffles, traps and adapters. Extensive tables of dimensional and operating data are included. **(Circle EQ RSC #55.)** CVC's vacuum ion pumps, Types PDV-30, PDV-300 and EI-200A, are shown in eight-page Bulletin, 6-2, which contains performance charts, schematic diagrams, specs and illustrations. **(Circle EQ RSC #56.)**

* * *

Conrad, Inc., Holland, Mich., has a four-page bulletin on Lexsol 408, a cooling fluid containing dissolved CO_2. Characteristics of the fluid, a chart of vapor pressures of various solvents and a table of physical properties are given. **(Circle EQ RSC #57.)**

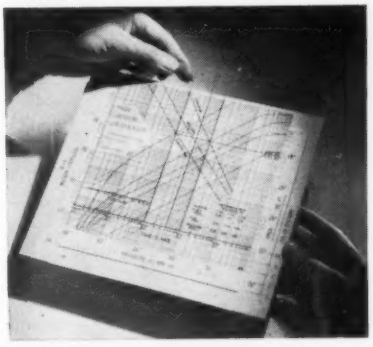
* * *

Endevco Corporation, Pasadena, Calif., has a preliminary two-page bulletin on its Model 2106 force gage. Gage has three force transducers in one plane, flat bases and center mounting hole. Specs and prices are listed. Illustrated. **(Circle EQ RSC #58.)**

* * *

Blue M Electric Company, B'ue Island, Ill., has issued a comprehensive 240-page, illustrated catalog describing its line of electric ovens, furnaces, baths, environmental cabinets and control equipment and accessories. Reference charts and tables are included. In color. **(Circle EQ RSC #59.)** In a six-page bulletin, Blue M describes its controlled humidity chambers, saturable reactor controls, water, oil and refrigerated baths and a portable cooling unit **(Circle EQ RSC #60)**, while a separate 12-page brochure lists

High Vacuum Calculator



A slide-rule type calculator for determining pump or chamber size and time and pressure of high vacuum systems has been developed by Consolidated Vacuum Corporation. Said to be the first for the high vacuum range, it is the outgrowth of a CVC paper at the '60 AVS Symposium. Measures 8½ x 11 inches. Priced at a non-profit $2, the calculator should be ordered direct from CVC, 1775 Mt. Read Blvd., Rochester 3, N. Y.

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For precise control of temperature by proportional regulation of AC power.

Power Ranges:
From 10 to 250 KW per phase. Single or 3-phase units available.

Temperature Ranges:
All temperatures that are measurable with thermocouples or radiation pyrometers.

Precise temperature control and power regulation are combined in one compact cabinet. User has only to provide power connections and temperature sensors. All-electronic temperature control and ignitron (or thyratron) power regulating circuitry provide high response (within one cycle of line frequency) and smooth, proportional control.

Equipment is applicable to control of electrical ovens or furnaces used for heat treating, enamelling, brazing, ceramic firing, testing, cooking, baking, etc.

RI RESEARCH INCORPORATED

Write Dept. LQ, Box 6164, Minneapolis 24, Minn.

its new line of mechanical convection ovens, including environmental cabinets, incubators and sterilizers. Details of the Power-O-Matic 60 saturable power reactor control system are given. **(Circle EQ RSC #61.)**

* * *

Varian Associates, Palo Alto, has a new 16-page catalog on the high-vacuum VacIon pump series and accessories. Operating principle, specs and illustrations are provided **(Circle EQ RSC #62.)**

* * *

Endevco Corporation, Pasadena, Calif., offers a pocket guide of common conversion factors, formulas and other data useful in measurements of environmental phenomena. Includes graph of piezoelectric transducer low frequency response vs. loading. **(Circle EQ RSC #68.)**

* * *

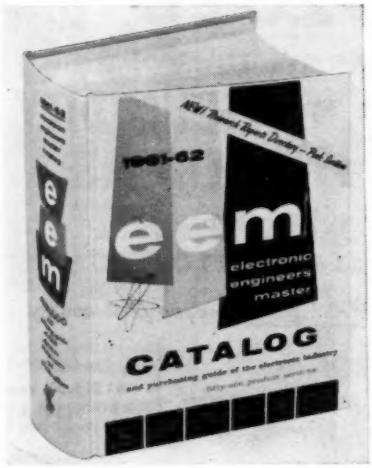
Consolidated Vacuum Corporation, Rochester, N. Y., has a 24-page revised bulletin on HYGE Series shock testers. Applications, operating principles and procedure, components and installation are thoroughly discussed and illustrated. Two sample problems with complete solutions and auxiliary diagrams are included. **(Circle EQ RSC #69.)**

* * *

Endevco Corporation, Pasadena, Calif., has issued the fourth edition of its Series 2200 accelerometer technical book. Numerous revisions incorporate recent state-of-the-art data on vibration and shock instrumentation. Applications, piezoelectric materials, mounting and calibration techniques are among the subjects discussed. **(Circle EQ RSC #70.)**

* * *

Biggest Directory Yet



The 1961-62 "eem" (Electronic Engineers Master) is being distributed to qualified electronics engineers and purchasing agents. According to Arthur Rabb, general manager of Tech Publishers, Inc., 60 Madison Ave., Hempstead, N. Y., it is the largest electronics catalog-directory ever published, with 1,952 pages, 51 product sections and more than 80,000 product sources. Cost to non-qualified persons is $15.

Environmental Business

(*Starts on Page 23*)

Lexsol to Conrad; Rep, Office Notes

Conrad, Inc., Holland, Mich., has been appointed national sales representative for Lexsol 408, a new liquid coolant that boils at +309°F and freezes at —125°F, produced by Santa Barbara Chemical Co. Warehouses are located in California and New York.

Mar-Tec Electronics, Inc., Los Angeles, is now distributing Ling Electronics vibration test equipment in California. Principals of Mar-Tec are Ernest Thornton and Robert Shaidnagle, both formerly in sales and marketing positions at Ling.

National Research Corporation, Cambridge, Mass., has established a sales office for its Metals and Research divisions in San Francisco. Kenneth A. Geiger, previously Metals division sales manager in Cambridge, is western manager for the division as well as representative for the Research division.

Technology Instrument Corporation, Acton, Mass., has moved its Long Island sales office from Manhasset to Great Neck, N. Y. The office also serves Westchester, Ulster, Putnam and Duchess counties in New York and Fairfield county in Connecticut.

Space-Tronics, Inc., Mineola, Long Island, N. Y., has been appointed exclusive representative of the Electroid Corporation, Union, N. J., for northeastern states.

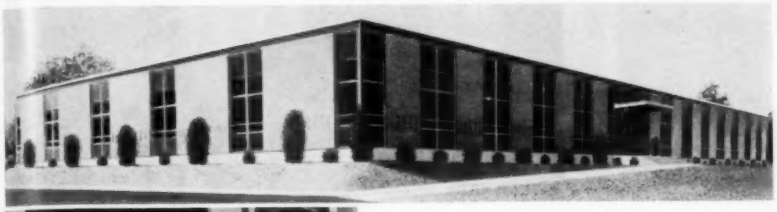
The Strong Electric Corporation, Toledo, Ohio, has named Lowry Dietrich Co. and Equipment Sales Co., Inc., as sales representatives. Dietrich, with offices in Cleveland and Dayton, is covering Pittsburgh area, northern and eastern Ohio and W. Va. and Ky. Equipment Sales handles New York, except New York City, and New England.

C. C. Moore and Company, Palos Verdes Estates, and Smith-Dietrich Sales Company, Inglewood, have been selected as engineering sales reps in southern California by General Acoustics Corporation, Los Angeles. Moore has been assigned prefab dust-free rooms, Smith-Dietrich prefab RF-shielded rooms.

American Research Corporation, Farmington, Conn., manufacturer of environmental test chambers, has appointed Equipment Sales Company, Inc., as New England and eastern New York sales representative for its entire line. Equipment Sales maintains offices in New Haven, Boston and Pittsfield.

CompuDyne Corporation, Hatboro, Pa., has opened an office at 1148 Englewood Avenue, Englewood, Calif., to service customers of its control systems and related instrumentation on the West Coast.

New Environment Place in New England



The building (above) is Associated Testing Laboratories, Inc.'s, recently opened environmental test lab in Burlington, Mass. Welcoming ATL's president, William Tonkowich (center) in front of the 13,500-foot installation on Route 128, 17 miles from Boston, is builder Rodger P. Nordblom (left). Joseph F. Beattie, general manager of ATL's New England division, is the third man. ATL's home plant and lab is in Wayne, N. J. It has another lab in Winter Park, Fla.

'Piezo' Shock Calibration

Endevco Corporation, Pasadena, Calif., has inaugurated a service of shock calibration to 15,000 Gs of any piezoelectric accelerometer weighing less than two ounces. System calibration will be furnished if cathode follower or amplifier is included. Also available is calibration service for sinusoidal excitation, temperature variations, high G level and cross-axis sensitivity. **(For more information circle EQ RSC "D".)**

Appointed to Cardox Post

Ralph S. Frost has returned to the Cardox organization as manager of applications engineering. He was Cardox' chief research engineer before 1958 when that firm was a subsidiary of Marmon-Herrington Co., Inc., and remained with Marmon-Herrington as director of research when the Chemetron Corporation acquired Cardox.

New Testing Facilities

Rototest Laboratories, Inc., Lynwood, Calif., has announced the availability of testing services at 10^{-6} mm Hg, a pressure equivalent to an altitude of about 500,000 ft, and facilities for 6000 amps, 28 v, regulated DC power for testing products such as high-power switches, relays and circuit breakers. **(For more information circle EQ RSC "E".)**

45 Sizes of Boosters

Roots-Connersville Blower division of Dresser Industries, Inc., Connors-

(Continued on page 46)

Reverse Order

Temperature-altitude chamber, custom built for Pan American World Airways by Aerotest Laboratories, Inc., Deer Park, N. Y., has refrigeration and compressor units on top so that it can stand on a work bench. Max alt: 90,000′, with 5,000′/min. climb rate. Temp range: —100°F in 55 min, +250° in a half hour. (For more info circle EQ RSC "N.")

Powerful Shake

Wyle Laboratories has installed this Ling Model 249 shaker with 120KW amplifier at its El Segundo laboratory. The water-cooled shaker is rated at 28,000 force pounds for random and 30,000 for sinusoidal vibration. A 10-ton crane handles large specimens.

LABLINE-HUDSON BAY

ENVIRON-CABS

provide most exacting temperature and humidity conditions for testing materials and components

No. 3960A— 10 cubic feet

Built to duplicate a wide range of environmental conditions. 4 sizes— 2 models, or custom-built to your requirements. Table models to Walk-in sizes available. Write for full information.

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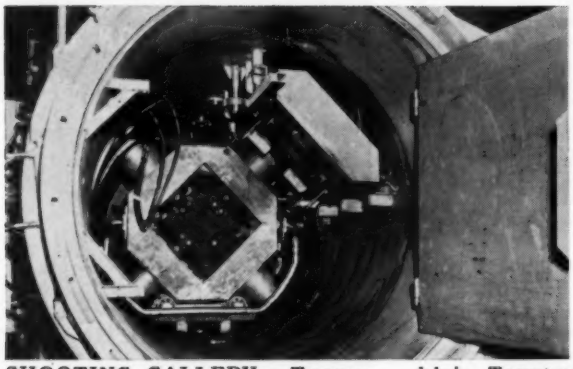

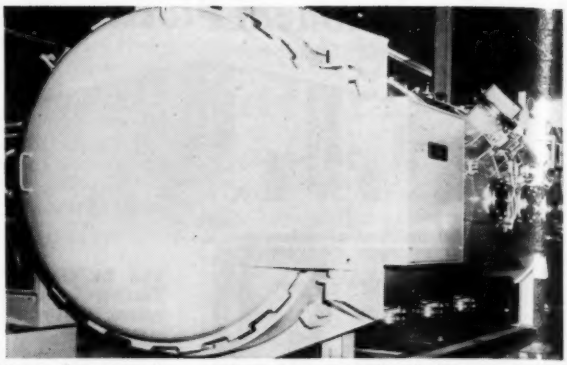

SHOOTING GALLERY: Tenney Engineering, Inc., Union, N. J., has delivered this evacuated target chamber to the Arnold Engineering Development Center, Tullahoma, Tenn., for testing the ability of various materials to withstand collision with celestial debris. Target materials can be stressed to 100,000 pounds in one or two directions and heated to 1,500°F while pellets are fired at tremendous velocities through a 10-inch wide, 30-foot "gun barrel" at 400,000 feet of altitude. Exterior view at left shows viewing ports and remote controls of the 6 x 18-foot simulator. At right, the view into the chamber shows rear door shield, the shield (upper right), behind which heating element retreats during firing, and target mount, which can be tilted 90 degrees.

Offers 45 Booster Sizes

(*Continued from page* 45)

ville, Ind., is offering a line of high-vacuum booster pumps for processing and environmental systems. Forty-five sizes are available for pressures from atmospheric to .5 micron Hg absolute with pumping speeds to 35,000 cfm.

The pumps are two-impeller, dry-type units with wide operating range, flat pumping speed curve and compression ratios from 10 to 15. Volumetric efficiency is approximately 90%. **(For more information circle EQ RSC "G".)**

Siren Noise Generators

American Measurement & Control, Inc., Waltham, Mass., has entered the acoustics field with a new line of "Acousti-Dyne" siren-type noise generating systems.

The product of 2½ years' development work in association with Bolt Beranek and Newman, Inc., Cambridge, Mass., the units are intended for research and proof testing of noise-induced fatigue in structures and components. **(For more information circle EQ RSC "F".)**

Minneapolis Test Lab

Environ Electronic Laboratories, Inc., Minneapolis, Minn., has been organized as specialists in testing electronic and electromechanical products to military specifications.

President and chairman of the new firm is William Docherty, formerly supervisor of the fixture laboratory evaluation department, Aeronautical division of Minneapolis - Honeywell Regulator Co.

ENVIRONMENTAL CHAMBERS COMBINE PORTABILITY with WALK-IN CAPACITY

Temperatures, altitude and humidity are available in Cincinnati Sub-Zero Products equipment with chamber sizes for ½ to 250 cu. ft.

The economy of portable, self contained equipment is illustrated by Model HASU-100-64-HC. The sixty-four cubic foot, stainless steel chamber provides low temperatures to minus 100°F—high to plus 200°F; altitudes to 100,000 ft. and humidity 20 to 95%. The cabinet, 90″ high x 60″ wide x 84″ deep is equipped with terminals, ports and window.

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